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GEOLOGICAL SURVEY OF CANADA.
ALFRED R. C. SELWYN, F.R.S., F.G.S., DIRECTOR.

MESOZOIC FOSSILS.

VOLUME I.

PART II.—ON THE FOSSILS OF THE CRETACEOUS ROCKS OF VANCOUVER AND ADJACENT ISLANDS IN THE STRAIT OF GEORGIA.

BY J. F. WHITEAVES, F.G.S.,
PALÆONTOLOGIST TO THE SURVEY.

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The Second Part of the present Volume contains identifications and descriptions of all the fossils collected by Mr. Richardson in 1871–75 from the Nanaimo and Comox Coal-fields of Vancouver and some of the islands in the Strait of Georgia, except the plants.

The figures on Plates XI. to XX. have been drawn and lithographed by Mr. A. H. Foord, F.G.S., the Artist to the Survey.

Part III., which is in course of preparation, will complete the Volume.

ALFRED R. C. SELWYN,
Director Geological Survey.

GEOLOGICAL SURVEY OFFICE,
MONTREAL, *May 6th*, 1879.

GEOLOGICAL SURVEY OF CANADA.

MESOZOIC FOSSILS.

BY J. F. WHITEAVES.

VOLUME I.

II. *On the Fossils of the Cretaceous Rocks of Vancouver and Adjacent Islands in the Strait of Georgia.*

Prefatory Remarks.

The fossils described in the following pages were collected by Mr. James Richardson from the south-eastern portion of Vancouver Island and from several islands in the Strait of Georgia, during the summer seasons of 1871 to 1875, inclusive. In order, however, to present as complete a report as possible on the present state of our knowledge of the fossil fauna of these deposits, the names of species described or recorded from them by other naturalists, but which were not met with by Mr. Richardson, have been added in their proper places between parentheses.

According to Mr. Richardson's published reports,* the coal-bearing strata of this part of Vancouver Island occupy a long, narrow strip on the shores of the Georgian Strait, but in the neighbourhood of Nanoose Harbour the continuity of the formation is broken by crystalline rocks, which divide it into two local and subordinate areas, one of which has been called the Comox, and the other the Nanaimo Coal-Field. The two together are believed to form part of a synclinal axis, whose north-east side lies beneath the waters of the Strait of Georgia, and the limits of each are shewn in detail in the maps which accompany Mr. Richardson's reports.

The Comox Coal-field extends from the north-west of North West Bay to Cape Mudge, and includes Denman and Hornby Islands. The following

* Geological Survey of Canada, Reports of Progress from 1871-72 to 1876-77, inclusive.

is a general section of the entire series as developed in this area, in descending order:—

COMOX SECTION.

	Feet.	In.
G. Upper Conglomerates	320	0
F. Upper Shales	776	6
E. Middle Conglomerates	1,100	0
D. Middle Shales	76	0
C. Lower Conglomerates	900	0
B. Lower Shales	1,000	0
A. Productive Coal Measures	739	6
Total	4,912	0

The Nanaimo Coal-field commences at a distance of about fifteen miles from Victoria and reaches to Nanoose Harbour, including within its boundaries a number of islands in the Georgian Strait, from the Sucia Group on the south-east, to Gabriola Island on the north-west. It has been found impracticable to define the upper groups of the Comox section in the Nanaimo area, and the rocks of the latter have accordingly been grouped provisionally, as follows:—

NANAIMO SECTION.

		Feet.
G. to C. Sandstones.	Thickness estimated at	3,290
B. Shales	" " "	660
A. Productive Coal Measures.	" " "	1,316
Total		5,266

From this it would appear that the thickness of the formation is somewhat greater in the Nanaimo than in the Comox area.

The organic remains obtained by Mr. Richardson from these deposits are, first, a small but interesting series of fragments of land plants, which have already been partly reported on by Principal Dawson, but which require further study; and, secondly, a collection of one hundred species of marine invertebrates, of which ninety-six belong to the Mollusca proper, three to the Brachiopoda, and one to the Anthozoa. Of the true Mollusca more than one-half the species are Lamellibranchiate bivalves, and in the same way the Gasteropoda are much more abundantly represented than the Cephalopoda.

In both coal-fields most of the shells are from Division A., but in the Comox area a considerable number of species were collected from the Lower Shales (Division B.) of the south-west side of Denman Island and elsewhere; also from the Middle Shales (Division D.) of the west and north-west side of Hornby Island. In the Comox basin only,

some fossil leaves and fragments of wood were found in the upper divisions (B. F. and G.,) also one or two obscure organisms in the middle conglomerates (E.,) but these last may have been derived from the underlying Middle Shales, or Division D.

The fossils, as a rule, are remarkably well preserved, but as they are nearly always much softer than the hard and tough matrix in which they are imbedded, it is difficult to hammer them out without breaking them. By far the largest number of species from any one locality, and the most perfect specimens, were collected by Mr. Richardson in 1874 and 1875 from the south-west side of the largest island of the Sucia group, in Washington Territory. These islands, however, as already mentioned, are situated within the limits of the Nanaimo Coal-field, and many of the species found in them occur also on Vancouver or on other islands in the Strait of Georgia.

In a paper read before the Geological Society of London in April, 1861,* and since printed in its proceedings, Dr. Hector says: "Some fossils transmitted to the Jermyn Street Museum many years ago" from Vancouver Island "were first rightly recognised by the late Professor E. Forbes, as being Cretaceous,"† but as far as the writer has been able to ascertain, no statement to that effect was ever published by Forbes. Mr. F. B. Meek appears to have been the first palæontologist who published specific descriptions of fossils from this part of the Vancouver Cretaceous. His earliest paper on the subject appeared in 1857, and from that year to the close of 1876, thirty-four species of mollusca from these rocks have been described either by Mr. Meek, Dr. B. F. Shumard, or Mr. W. M. Gabb. The following are the titles of the papers in which these descriptions are to be found, with references to the publications in which they appeared:—

1857. *Meek, F. B.*—"Descriptions of New Organic Remains from the Cretaceous Rocks of Vancouver Island." Transactions of the Albany Institute, Vol. IV., pp. 37-49.

Twenty species of mollusca from Nanaimo are characterised in this paper.

1858. *Shumard, Dr. B. F.*—"Descriptions of New Fossils from the Tertiary formations of Oregon and Washington Territories and the Cretaceous of Vancouver's Island, collected by Dr. John Evans, U. S. Geologist, under instructions from the Department of the Interior." Transactions of the Academy of Science of St. Louis, Vol I., pp. 120-125.

Three of the species are from Nanaimo.

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* "On the Geology of the Country between Lake Superior and the Pacific Ocean (between the 48th and 54th parallels of latitude), visited by the Government Exploring Expedition under the command of Captain J. Palliser. By James Hector, M. D."—Quart. Jour. Geol. Soc. Lond., Vol. XVII, pp. 388-445.

† Do. p. 429.

from the "Productive Coal Measures," or Division A., of the Sucia Islands,* in the summer of 1874. The most perfect of these has already been briefly characterised on page 17 of this volume, but the statement there made that "the siphuncle is situated a little on the outside of the centre of the septa," has since been found to be incorrect, and the inferences drawn under this impression, viz., that the shell is probably only a variety of *Nautilus Atlas* (nobis), and that it agrees almost exactly with Meek's diagnosis of the Nebrasca shell figured as *N. elegans*, are, of course, no longer tenable. When the first description of the Sucia Island *Nautilus* was written, the lower part of the only septum in which the siphuncle could be traced was covered by the matrix, and sufficient allowance was not made for the depth of the emargination at its base. While endeavouring, subsequently, to remove part of the matrix, a piece of the septate portion became detached in such a way as to expose the whole of the convex surface of this septum, the eighth from the aperture, most of which had previously been hidden from view. On account of the rounding off of the margin it is difficult to give very accurate measurements, but, as nearly as can be ascertained, the height of this septum, in the centre, is nine lines, and the middle of the siphuncle is about five lines from the outer and four from the inner margin of the septum. In the other specimen, which is a cast of the body chamber, with one of the so-called air chambers attached, the whole of the convex side of the last septum but one is fully exposed. Following its convexity throughout, along the median line, the total height of this septum is twenty-three lines, and the centre of the siphuncle is thirteen lines distant from the periphery and ten lines from the inner margin of the septum. Thus it would appear that the siphuncle is placed a little on the inner side of the centre, at a distance from it about equal to its own diameter.

This species seems to be more closely allied to the *Nautilus Albensis* and *N. Neckerianus*, as described by Pictet and Campiché in the Paléontologie Suisse, than to any of the ribbed Nautili from the Cretaceous rocks of North America. In *N. Albensis* the siphuncle is situated at one-third the height of the septum, on the inner side of its centre, and this is the only difference at present obvious between it and *N. Suciensis*. The position of the siphuncle appears to be precisely similar in *N. Neckerianus* and *N. Suciensis*, but the former shell has much more

* The words "Sucia Islands," as applied to specimens collected by Mr. Richardson, are invariably employed as an abbreviation for south-west side of the largest island of the Sucia group.

numerous and more strongly marked ribs, which are alternately short and long, and its umbilicus, though closed in some specimens, is open enough in the majority to expose some of the inner whorls. *Nautilus Neckerianus*, moreover, is one of the characteristic fossils of the Lower Greensand, whereas the rocks in which *N. Suciensis* occurs can scarcely be older than the Gault, and are probably of a much more recent date.

Nautilus Campbelli, Meek.

Plate 11, figures 2, 2*a* and 2*b*.

Nautilus Campbelli Meek.—Proc. Ac. Nat. Sc., Phil., 1861, page 318.
" " " Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, p. 373, pl 6, figs. 2, 2*a*.

Comox, Vancouver Island. Meek. Middle Shales, Division D., of the North-West side of Hornby Island; J. Richardson, 1872; and Productive Coal Measures, or Division A., of the Sucia Islands; J. R., 1875. One specimen from each locality.

The position of the siphuncle of *Nautilus Campbelli* was unknown to its describer, but the two specimens collected by Mr. Richardson, both of which are half-grown shells, shew this character with great clearness, and give some additional information about the species. The siphuncle is placed very near to the inner margin of the septum, its distance from the periphery being four-fifths the entire height, at least, in comparatively young shells. The septum figured is the largest one obtained: following its concavity the entire height along the median line is ten lines, and the centre of the siphuncle is eight lines from the outer and two from the inner margin. The umbilicus is deep but narrow, and remains of it are sometimes left as hollow, funnel-shaped, shelly cones projecting on either side of the early volutions. The surface of the latter, as viewed under an achromatic microscope with an inch and a-half objective, is seen to be marked by shallowly concave revolving grooves, and these are crossed by rather distant, transverse, crenate ridges, the intervals between which are almost filled by close set, numerous crenate striæ which run parallel both to each other and to the ridges.

(Nautilus Dekayi, Morton.

Nautilus Dekayi, Morton.—Synops. Org. Rem. Cr. Rocks of U. S., p. 33, pl. 8, fig. 4.
" " " Meek, Rep. Inv. Cr. and Tert. Foss. of U. Miss. Co., p. 496, pl. 27, figs. 1*a*, *b*, *c*, *d*, *e*.

On page 124 of the first volume of the Transactions of the Academy of Science of St. Louis, dated 1857, Dr. B. F. Shumard says that "a

Nautilus which appears to be identical with *N. Dekayi*, Morton," occurs in "the dark, argillaceous, compact limestone of Nanaimo River, Vancouver Island," associated with *Inoceramus Vancouverensis* and other Cretaceous fossils. Imperfect or badly preserved specimens of *Nautilus Campbelli* are difficult to distinguish from *N. Dekayi*, and as Dr. Shumard states that his fossil was in bad condition, it is quite likely that the *Nautilus* which he supposed might be *N. Dekayi* was really *N. Campbelli*, especially when it is borne in mind that the latter species was not described by Meek until 1861, four years after the publication of Dr. Shumard's paper. However this may be, the existence of *Nautilus Dekayi* in the Vancouver Cretaceous is not very satisfactorily established, and needs confirmation. It has not yet been recorded from rocks of similar age in California.)

(HETEROCERAS COOPERI, GABB. (Sp.)

Ammonites (?) Cooperi, Gabb.—Palæontology of California, Vol. I., p. 69, pl. 14, figs. 22 and 23*a*.

Heteroceras Cooperi, Meek.— Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, p. 367, pl. 3, figs. 7 and 7*a*.

Comox, Vancouver Island. Meek. Not in any of Mr. Richardson's collections.)

HETEROCERAS CONRADI, MORTON. (Sp.)

Plate 12, all the figures.

Ammonceratites Conradi, S. G. Morton.—Jour. Ac. Nat. Sc., Phil., 1839, Vol. VIII., p. 212, pl. 10, fig. 1.

More or less fragmentary specimens of a large *Heteroceras* were collected by Mr. Richardson, from the Middle Shales, or Division D., of the North-West side of Hornby Island (one) in 1872; from the Lower Shales, or Division B., of the Trent River (two from above and one from below the falls), and at Bradley Creek, V. I., in 1872; also from the Productive Coal Measures, Division A., of Salt Spring or Admiralty Island (two), and at Maple Bay, V. I. (five), in 1875.

The most perfect are those from the last mentioned locality, three of which are represented on plate 12. The original of figs. 1 and 1*a* in that plate has an entire whorl and a considerable portion of the two preceding ones preserved in place, also a detached piece of the uncoiled part of the shell, which was found lying immediately across its umbilical opening

and partly covered by the matrix, which has since been removed. Figs. 2 and 2*a* are different views of a fragment, which consists of one of the earliest volutions, evidently not far from the nucleus, and fig. 3 is a part of the shell which corresponds very nearly to the piece described by Morton as *Ammonceratites Conradi*. The specimens are often distorted, yet taken collectively they give a tolerably good general idea of the shape and sculpture of most of the shell. The whorls are rounded and are at first coiled in a dextral and somewhat regular spiral, but the last one is free and partially uncoiled. Those of the spire are contiguous, and are enrolled in such a manner as to leave a very deep and moderately wide umbilical cavity which extends nearly to the nucleus. The width of the umbilicus is rather less than one-third that of the greatest diameter of the shell (which measures three inches and a-quarter in the largest specimen,) and it is as wide in proportion in the earliest volution known. The number of whorls in the coiled part was probably about five, and the height of the spire appears to have exceeded its greatest width. The exact direction taken by the free termination of the shell is not yet known. In some specimens, especially in that from which fig. 3 was taken, the whorl suddenly takes a decidedly upward curve apparently just previous to uncoiling, but in another individual (which, however, is obviously distorted) the upward curve is not quite so strongly marked and it subsequently seems to slope convexly downwards again.

The surface is marked by rather distant, prominent and very acute, transverse ribs, which are much narrower than the rather deeply concave grooves between them. The ribs are flexuous above and comparatively straight on the lower or umbilical face: in most specimens they are both simple and parallel, but in one example some of the costæ bifurcate near the middle of the sides. Septum unknown.

The writer has long been convinced that the fossils described above are specifically identical with the New Jersey *Heteroceras* described and figured by Morton under the name *Ammonceratites Conradi*, and Mr. G. W. Tryon, who has compared the two best Maple Bay specimens (the originals of figures 1 and 3 of plate 12) with Morton's type of *A. Conradi*, and with another cast of the same species, from Shell Town, N.J., labelled by Mr. Conrad, both in the Museum of the Academy of Natural Sciences of Philadelphia, has come to the same conclusion. In a letter, dated March 5th, 1878, Mr. Tryon says: "I have carefully compared your specimens of *Heteroceras* with our types and find no difference which cannot be assigned to compression. The ribs on your specimens are

much more sharply defined than on ours, your casts being very much more perfect, but the relative sizes of ribs and interspaces are the same."

AMMONITES.

Group I.—Lævigati, Forbes.

SUB-GENUS HAPLOCERAS, Zittel.*—"Palæontologische Mittheilungen dem Museum des Kœniglichen Bayer. Staats." Cassel, 1870. Vol. II., p. 166.

AMMONITES GARDENI, BAILY.

Ammonites Gardeni Baily.—Quart. Jour. Geol Soc., London, 1855, Vol. II., p. 456, pl. 11, fig. 3.
" " " Stoliczka, Cret. Ceph. S. India, p. 61, pl. 33, fig. 4.

Lower Shales, Division B, at Bradley Creek (two specimens), and on the banks of the Trent River, V. I., above the falls (one example); also Productive Coal Measures, Division A, ten miles up the Nanaimo River, V. I.; J. Richardson, 1872 and 1874.

Ammonites Gardeni has a very wide geographical distribution. The specimens originally described by Baily were from Cretaceous deposits in the neighbourhood of Natal, and the species has since been found in rocks of similar age at three different localities in Southern India. Dr. Stoliczka thinks that the *Ammonites sulcatus* of Kner, from Lemberg in Austrian Poland, may be synonymous with *A. Gardeni*, and if this be the case the latter shell occurs also in Europe. The four Ammonites from the above mentioned localities in Vancouver Island are referred to *A. Gardeni* with some confidence.

(AMMONITES GENICULATUS, CONRAD.

Ammonites geniculatus, Conrad.—Emory's Rep. on the U. S. and Mex. Bound. Surv., 1857, Vol. I., p. 159, pl. 15, figs. 2*a*, b.

Identified by Mr. Etheridge as occurring at Comox or Valdez Inlet,† but no other naturalist has met with it in the Vancouver Cretaceous. The only Ammonite with a simple keel in Mr. Richardson's collections is *A. Gardeni*.)

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* Teste Neumayr, in a paper entitled "Die Ammoniten der Kreide und die Systematik der Ammonitiden." Zeitschrift der Deutschen Geologischen Gesellschaft, Berlin, 1875, Vol. XXVII., p. 915.

† Quarterly Journal of the Geological Society of London, April, 1861, Vol. XVII., page 434.

Group II.—Dentati, Von Buch.

Sub-genus Placenticeras, Meek.—Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country. Washington, 1876. Pages 462 and 463.

Ammonites Vancouverensis, Meek.

Ammonites Vancouverensis, Meek.— Proc. Ac. Nat. Sc., Phil., 1861, Vol. XIII., p. 317.

Placenticeras (?) Vancouverensis, Meek.—Bul. Geol. and Geogr. Surv. Terr., Vol. II., No. 4, p. 370, pl. 6, figs. 1, 1*a*, 1*b* and 1*c*.

Comox, Vancouver Island. Meek. Sucia Islands, in Division A.; J. Richardson, 1874. Three characteristic examples.

Group III.—Heterophylli, D'Orbigny.

Sub-genus Phylloceras, Suess.—"Ueber Ammoniten." Sitzungsberichte der K. K. Akad. der Wissenschaften. Vienna, 1865. Vol. LII., p. 52.

Ammonites Velledæ, Michelin.

Ammonites Velledæ, Mich., D'Orb. —Pal. Franc., Terr. Cret., Vol. I., p. 260, Atlas, pl. 82.

" " " Pictet —Pal. Suisse, Foss. de St. Croix, Vol. I., pp. 268 and 348, pl. 36, fig. 8.

" " " Stoliczka —Cret. Ceph. S. India, p. 116, pl. 59, figs. 1–4.

Ammonites (Scaphites?) ramosus, Meek.—Trans. Alb. Inst., 1857, Vol. IV., p. 45.

*Phylloceras ramosus** (sic), Meek. —Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, p. 371, pl. 5, figs. 1, 1*a*, and 1*b*.

Comox, Vancouver Island. Meek. Sucia Islands, in Division A.; J. Richardson, 1874. One well preserved fragment.

An attentive consideration of the diagnoses and figures of the two shells, has forced the writer to the conclusion that the *A. ramosus* of Meek is synonymous with the *A. Velledæ* of Michelin and other European palæontologists.

Mr. Meek, after admitting that the shape and surface markings of both are alike, goes on to say: "When we compare the septa, however, they are at once seen to present marked differences, such as are clearly incompatible with specific identity, *if D'Orbigny's figures are correct.*" The qualification italicized shews that Meek had not compared his shell with either Pictet's or Stoliczka's descriptions or illustrations of *A. Velledæ*.

* Meek writes this word "ramosus," but Phylloceras is neuter.

In D'Orbigny's figure of the septum of *A. Velledæ*, the siphonal saddle (or small saddle through which the siphon passes) is represented as lanceolate with an entire margin; whereas the corresponding saddle in *A. ramosus* is figured by Meek as three lobed or twice incised at the summit, and this difference might be, and indeed has been, looked upon as of specific importance. The value of this character, however, is entirely negatived by the fact that Pictet and Stoliczka both represent the siphonal saddle of *A. Velledæ* as three lobed or twice incised at the apex, and their figures of the septum of that species agree precisely with Meek's drawing or tracing of the septum of *A. ramosus*. The plates of Ammonites in the first volume of the "Paléontologie Suisse" shew that the shape of the siphonal saddle varies considerably in different individuals of the same species, and suggest grave doubts as to the validity of distinctions which are founded only on supposed differences in this part of the septa*.

Ammonites Selwynianus. (N. Sp.)

Plate 13, figures 1 and 1a.

Shell somewhat compressed at the sides and rounded on the periphery; umbilicus extremely small; surface of the test marked by fine, flexuous striæ, which curve forwards and form long beak-like processes on the siphonal edge; cast impressed by distant, periodic grooves, which curve in the same direction as the striæ on the test.

Whorls strongly involute, nearly the whole of the inner turns being concealed; outer volution moderately inflated, thickest near the middle of the sides and slightly depressed round the umbilical opening. Umbilicus rather less than one-tenth of the greatest diameter of the shell, very deep, with a rounded margin and almost perpendicular sides. Aperture ovate, wider above than below, and very deeply emarginate for the reception of the previous volution. Measured along the median line, where the emargination is deepest, the width of the aperture is greater than its height, but outside of the emargination the entire height of the whorl or aperture is much greater than its width.

Test ornamented by faint and very delicate, flexuous striations,

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*On pp. 43-45 of the present Volume, five Ammonites from the Queen Charlotte Islands were described under the name *A. filicinctus*, and these were separated from *A. Sacya* (Forbes) on precisely the same grounds as those which were relied upon by Meek for distinguishing his *A. ramosus* from *A. Velledæ*—viz., a supposed difference in the shape of their siphonal saddles. At the time that *A. filicinctus* was described, the writer had not access to the "Paléontologie Suisse," and consequently was not then aware that the shape of the siphonal saddles was variable in different specimens of the same Ammonite; but the work referred to has since been added to the Library of the Survey, and it is now almost certain that *A. filicinctus* is identical with *A. Sacya*.

which commence at the umbilicus, curve a little forwards and then gently backwards across the sides, after which they form a series of elongated, beak-like processes with concave sides in passing over the periphery, Underneath the shell there are seven constrictions or grooves on the east of the outer whorl. These are the remains of former lips, whose curves are precisely parallel with the flexuous striæ of the test. Septation unknown.

Greatest diameter of an average sized individual, twenty-seven lines; width of umbilicus of the same, not quite two lines and a-half. Maximum width of the aperture, ten lines and a-half; height of do., outside of the emargination, fourteen lines; depth of the emargination, six lines and a-half.

Sucia Islands, in Division A.; J Richardson, 1874. Nine good specimens.

This species appears to be more closely allied to *Ammonites subalpinus*, D'Orbigny, and *A. diphylloides*, Forbes, then it is to *A. ramosus* or *A. Velledæ*. Besides having much flatter shells than *A. Selwynianus*, the casts of *A. ramosus* and *A. Velledæ* are devoid of periodic grooves or constrictions and their test is finely ribbed. Casts of *A. subalpinus* and *A. diphyllcides* are impressed by transverse furrows at distant intervals, but in these species the radiating striæ of the test and the furrows beneath it are not developed on the siphonal edge into the beak-like processes which are characteristic of *A. Selwynianus*.

Ammonites Indra, Forbes.

Plate 13, figures 2 and 2a.

Ammonites Indra, Forbes.—Trans. Geol. Soc., Lond., 1846, Vol. VII. p. 105. pl. 11, fig 7.
" " " Stoliczka Cret. Ceph. of S. India, p. 112, pl. 58, fig. 2.

The exquisitely preserved Ammonite figured on plate 13 was found by Mr. Richardson imbedded in a large concretion or nodule from the Middle Shales (Division D.) of the North-West side of Hornby Island, in the summer of 1871. The shell is rather more than five inches in diameter, and although its siphonal lobes and saddles are everywhere covered by the test, it is in much better condition than any of the Indian specimens of *A. Indra* described by Forbes or Stoliczka, with whose characters it agrees in every essential particular. The faint transverse furrows of the surface are, perhaps, proportionally more distant in the Hornby Island Ammonite than they are represented to be in Stoliczka's figures of *A. Indra*, but this is doubtless only an individual peculiarity.

The detached fragment from which figure 2*a* of plate 13 was drawn was broken out of the same argillaceous nodule as the Ammonite, and probably once formed part of the shell of the latter. If this supposition be correct, it would appear that the outer lip of the adult shell when perfect bore a simple, elongated and rather narrowly rounded lobe or ear on each side.

Two very small Ammonites, collected by Mr. Richardson on the South-West side of Denman Island, in Division B, the largest of which is less than three-quarters of an inch in its greatest diameter, are believed to be also referable to *A. Indra*.

Group IV.—Macrocephali, Von Buch.

Sub-genus Stephanoceras, Waagen (Pars.)—Geognostich-Palæontologische Beitrage, Von Dr. E. W. Benecke, Munchen, 1869, Vol. II., p. 248.

Ammonites complexus, var. Suciensis, Meek.

Ammonites complexus, var. *Suciensis*, Meek.—Proc. Ac. Nat. Sc., Phil., 1861, Vol. XIII., p. 317. Bul. Geol. and Geogr. Sur. of Terr., Vol. II., No. 4, p. 369, pl. 5, figs. 2, 2*a*, *b* and *c*.

Ammonites Brewerianus, Gabb (Pars.) —Pal. Cal., Vol. I., pl. 27 and pl. 28, fig. 19, but not those figured under the same name on plate 10 of the same volume.

Ammonites complexus of Hall and Meek, from the Cretaceous deposits of the Upper Missouri country and Atlantic coast, was described from small and imperfect specimens, and the characters of the species are very imperfectly ascertained. In reference to the very similar Ammonite from Comox and the Sucia Islands, Mr. Meek remarks—"After a careful comparison I am left in doubt whether it should be regarded as a variety of *A. complexus* (Hall and Meek) or as a distinct species." "It certainly is a much more compressed shell; the volutions of *A. complexus* being nearly twice as wide transversely as from the dorsal to the ventral side, while these two diameters of the whorls in the form before me are nearly equal." "Differences of this kind, however, are not generally reliable as a means of distinguishing species in this group; though the few specimens yet brought from Nebraska, as well as those found in New Jersey, do not shew any essential variations in this respect."* This

* Bulletin of the Geological and Geographical Survey of the Territories, Washington, 1876. Vol. II., No. 4, p. 362.

question cannot be satisfactorily solved until more perfect examples and a larger series of the typical *A. complexus* are obtained.

The specimens collected by Mr. Richardson, which belong to the variety *Suciensis*, are as follows:—

1. A very perfect and typical example, from the Sucia Islands, in Division A. It measures nearly four inches in its greatest diameter, and corresponds exactly in septation, shape and surface markings with the smaller of the two individuals figured by Meek on plate 5 of Vol. II., No. 4, of the Bulletin of the Geological and Geographical Survey of the Territories. Its sculpture is much like that of the type of *A. complexus*, but its whorls are much more compressed at the sides. In this latter respect it accords perfectly with the characters of the variety *Suciensis* as defined by Meek.

2. A large cast from Division A, at North-West Bay, V. I., which measures rather more than six inches across. The inner whorls are crushed and imperfect, and only a few vestiges of the septation can be traced. Near the umbilical margin the elongated nodes on the longer ribs are almost obsolete, and the ribs themselves, though perhaps a little fainter on the periphery than on the sides, are yet prominent enough to decidedly interrupt the outline of the shell at its circumference. This fossil is almost certainly conspecific with the large Vancouver Island Ammonite represented by Mr. Gabb on plate 27 of the first volume of the Palæontology of California as *A. Newberryanus*, although in the figure there given the ribs do not break the general contour of the shell. Both have the subglobose form, the comparatively small umbilicus, with its slopingly convex sides, and the entire absence of the periodic arrests of growth which distinguish *A. complexus*, var. *Suciensis* from the true *A. Newberryanus*. The ramifications of the lobes and saddles in the shell figured by Mr. Gabb also are far more complex than they are in the type of *A. Newberryanus*, and, in fact, they are more numerous and crowded than they are represented to be in Meek's figure of *A. complexus*, var. *Suciensis*. In 1875 Mr. Meek kindly sent the writer photographs of the original drawings of the types of the whole of the species described by him from Vancouver and the Sucia Islands, for comparison with Mr. Richardson's specimens. A careful study of both led to the opinion already expressed, which was communicated to Mr. Meek on the 29th of August, 1876, before his last paper on these fossils had been received, but rather more than three weeks after the date of its publication. In a letter, dated Afton, Virginia, September 8th, 1876, Mr. Meek replied as follows: "Not having the California reports at hand, I am unable to

give you any reliable information in regard to the shells referred by Mr. Gabb to *Ammonites Newberryanus* and *A. complexus*, var. *Suciensis*. I remember, however, that I have stated, in my little report on the North-West Boundary and Vancouver Fossils, that *A. Newberryanus* of Gabb is not the form described by me under that name. Mr. Gabb also arrived at the same conclusion after the publication of his report. It is quite probable, as you say, that his *A. Newberryanus* may be my *A. complexus*, var. *Suciensis*."

3, 4, 5 and 6. Four specimens from the banks of the Trent River, V. I., in Division B, one from above and three from below the falls. Two are about four inches in diameter, and these, though tolerably perfect, are somewhat distorted and have much of the sculpture obliterated, as well as some of the finest ramifications of the sutures. The others are about half that size, and one of these has the siphonal lobes and saddles beautifully preserved, as well as part of the test. The septation of all four, as far as it can be traced, appears to be exactly like that of Meek's type of *A. complexus*, var. *Suciensis*, with which they seem to agree also in all the essential characters, though they present the following unimportant variations from Nos. 1 and 2:—They are decidedly more globose; the height of their apertures, outside of the emargination, being less than the width, in which respect they approach nearer to *A. complexus* proper; the ribbing is also somewhat stronger than is usual in shells of that size and the ribs curve forwards on the periphery in a series of shallowly convex arches; whereas, in No. 1, at least, they cross the siphonal edge in almost a straight line. At first sight, too, the surface seems to be marked by periodic thickenings of the shell, or by corresponding constrictions or grooves on the cast, which appear to be placed at short but regular intervals. When more closely examined into this appearance is seen to be due to the fact that the ribs which proceed from the umbilicus are broader and higher than those which become obsolete before reaching its margin, and that between each pair of the former there are from two to five of the latter.

These four Ammonites from the Trent River are almost certainly conspecific with the *A. Deccanensis* of Stoliczka.

Group 5.—*Ligati, D'Orbigny.*

Sub-genus Perisphinctes? Waagen.—"Geognostich-Palæontologische Beitrage," Von Dr. E. W. Benecke, Munchen, 1869. Vol. II., p. 248.

Ammonites Newberryanus, Meek.

Plate 14, figs. 1 and 1*a*.

Ammonites Newberryanus, Meek.—Trans. Alb, Inst., 1857, Vol. IV., p. 47.
" " Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, p. 367, pl. 4, figs. 3, 3*a* and 3*b*.

Comox, V. I., Meek. Middle Shales, Division D, North-West side of Hornby Island, one specimen; J. Richardson, 1871. Lower Shales, Division B, of Brown's River (one), and lower part of the Trent River (two), V. I.; also South-West side of Denman Island (one); J. Richardson, 1871. Productive Coal Measures, Division A, from North-West Bay, V. I., J. Richardson, 1873, ten specimens; and from the Sucia Islands (six do.); J. Richardson, 1874. Most of these are casts; but two individuals from the Sucia Islands have the pearly inner layer of the test beautifully preserved, and a specimen from North-West Bay shews the porcellanous outer layer also.

Although typical and well preserved examples of this and the preceding species may be distinguished from each other without much difficulty by the help of Mr. Meek's descriptions and figures, it is by no means easy to identify water-worn or imperfect specimens of either, and aberrant or partly intermediate varieties occur, which are very puzzling.

The characters by which *A. Newberryanus* can be most readily separated from *A. complexus*, var. *Suciensis*, are four in number, and these may be briefly stated as follows:—

1. The lobes and saddles of *A. Newberryanus*, especially those on or near the periphery, are shorter, smaller and much less divided than are those of *A. complexus*, var. *Suciensis*. Thus in *A. Newberryanus* the siphonal lobe has *three* principal branches on each side, and these are again divided at their summits into two or three branchlets. In *A. complexus*, var. *Suciensis*, the siphonal lobe has *four* branches on each side, and the apices of both are divided into four or five unequal, spreading branchlets.

2. Nearly all the specimens collected by Mr. Richardson, which in other respects correspond with the typical *A. Newberryanus*, have their whorls much more compressed laterally than is the case with *A. complexus*, var. *Suciensis*. Their dorso-ventral diameter exceeds their width by

about one-third, and the shape of their aperture, apart from the emargination, is elliptic-ovate, the width being greatest at the base. Mr. Meek, however, says that the dorso-ventral diameter of the whorls in *A. Newberryanus* is nearly or quite equal to their transverse breadth.

3. The umbilicus of this species is proportionately wider than it is in *A. complexus*, var. *Suciensis*, and exposes more of the inner whorls.

4. Besides being regularly ribbed, the surface of *A. Newberryanus* is marked, at distant but somewhat regular intervals, by transverse, swelling rims, the remains of former lips. In a specimen not quite five inches in diameter there are seven of these in the outer whorl. They may be easily distinguished from the ribs by their much larger size, also by the circumstance that they are convex on the inner as well as on the outer surface of the test, which is evinced by the broad grooves they leave on the cast.

Of the twenty-one specimens collected by Mr. Richardson only two shew the septation at all. One of these is a water-worn cast in which many of the finest ramifications of the sutures are effaced, and the other is a fragment of a very young individual, whose lobes and saddles are partly covered by the test. Nineteen have the flattened whorls, the comparatively wide umbilicus, and the periodic arrests of growth characteristic of *A. Newberryanus*, but two large, though imperfect individuals, both from North-West Bay, V. I., differ from the rest in some rather important particulars. The whorls are not nearly so much flattened at the sides, their height and width being almost equal: the umbilicus has slopingly convex sides and the ribbing appears to be sharper than in average specimens. Still, the umbilical opening of these shells is wider than in *A. complexus* var. *Suciensis*, more of the inner whorls are exposed than in that species, and the thickening of the lip at regular intervals, (traces of which, at least, are always to be seen in the true *A. Newberryanus*) though more obscure than usual in these two specimens, is nevertheless perceptible.

Mr. Meek's description of this species leaves nothing to be desired as regards accuracy, so far as it goes, but it was based on a single worn cast not more than two inches and a quarter across, and consequently does not express the whole of the characters of the shell. When fully grown *A. Newberryanus* must have attained to a very large size, for a specimen from the Sucia Islands measures eighteen inches across, and it consists entirely of septate whorls. With an increase of age, after a certain point the ribs and other surface markings gradually become wider apart, flatter and fainter, until at last they disappear altogether. In the large Sucia

Island shell just mentioned, the outer whorl is entirely smooth, and in the previous volution to that, the ribbing is almost obsolete. The sculpture of half-grown examples of *A. Newberryanus*, the condition in which it is most frequently met with, is subject to much variation, and the single row of nodes around the umbilicus on both sides, which Mr. Meek seems to regard as one of the most marked peculiarities of the species, is often absent.

It is just possible that *A. Newberryanus* may be only a geographical variety of *A. planulatus* Sowerby, for the septation of the two shells is very similar, the whorls of both are flattened at the sides, and each have about the same number of periodical arrests of growth. The main points in which they differ are that all the ribs of *A. planulatus* become obsolete before reaching the umbilicus, which is certainly not the case in *A. Newberryanus*, and that in *A. planulatus* the ribs arch forwards on the periphery, whereas they are straight in the same region in *A. Newberryanus*. The umbilicus of *A. planulatus* is generally wider in proportion to the shell, than is that of *A. Newberryanus*, but Stoliczka figures an Indian specimen of *A. planulatus* in which the umbilicus is not any wider than it is in Vancouver examples of *A. Newberryanus* of the same size.

Group 6.—Fimbriati, D'Orbigny.

Sub-genus Lytoceras, Suess.—Sitzungsberichte der K. K. Akad. der Wissenschaften. Vienna, 1865.

Ammonites Jukesii ? Sharpe.

Plate 13, figures 3, 3*a* and 3*b*.

Ammonites Jukesii,? Sharpe.—Description of the Fossil Remains of Mollusca found in the Chalk of England, p. 53, pl. 23, figs. 11, *a* to *e*.

" " " Pictet and Campiche. Pal. Suisse, Foss. de Ste Croix. Page 350.

Shell composed of numerous slightly involute rounded whorls; umbilicus large and open; surface finely costulate and marked with distant, nearly transverse but flexuous elevations, the remains of former lips.

Whorls seven or eight, rounded, but widest near the umbilical margin and narrowing a little towards the periphery; dorso-ventral diameter of the whorls, outside of their shallow internal emargination, rather less than the greatest width of their sides. Umbilicus wide, its margin and sides abruptly rounded; measured from suture to suture its width is rather more than half the maximum diameter of the shell; sides of the whorls fully exposed; sutures distinct. Aperture transversely reniform, fully

one-third wider than high, if measured along the median line where the emargination is deepest.

Surface finely ribbed and marked by periodic arrests of growth. The ribs are flexuous and curve distinctly forwards, they are also acute and much narrower than the concave grooves between them. Nearly all the ribs are simple but occasionally one may be seen to bifurcate near the umbilical margin, and there are very obscure traces of still finer and shorter secondary ribs intercalated between the larger one. The costation, too, though certainly minute, is still rather plainly visible to the naked eye. In each whorl there appear to be about four distinct arrests of growth. These consist of rounded elevations, which are broader and more prominent than any of the ribs, but which run almost exactly parallel with them, and which are as strongly marked on the cast as they are on the shell. The ribs, on the contrary, are too minute to leave any definite impressions on the cast. Septation unknown.

Maximum diameter, seventeen lines and a-half; width of umbilicus, from suture to suture, rather more than nine lines.

Lower Conglomerates, Division C, of Norris Rock, a small "Island about a mile S. 60° E. from Norman Point, which is the most southern part of Hornby Island"; J. Richardson, 1871. A fragment only of the inner whorls.

The above description is not intended as a specific diagnosis, but merely as a brief summary of the characters exhibited in the imperfect and immature individual represented on Plate 13. The type of *A. Jukesii* (from the Hard Chalk of the County of Londonderry, Ireland) is also a single fragment of an Ammonite, in much the same condition as the present shell, but which, Mr. Sharpe says, when perfect, probably measured five or six inches in diameter. In the figures of this specimen the inner whorls appear to be more flattened at the sides than the corresponding volutions of the Ammonite from Norris Rock are, but at present no other differences of any consequence can be pointed out between the two shells.

(HAMITES VANCOUVERENSIS, Gabb.

HAMITES VANCOUVERENSIS, Gabb.—Pal. Cal., Vol. I., p. 70, pl. 13, fig. 18.

"Vancouver Island, associated with *Ammonites Newberryanus* and other Ammonites, species undetermined."—Gabb. Not recognised in any of Mr. Richardson's collections. A large species whose septation is unknown, but which is characterized by its prominent, distant ribs, each of which bears a tubercle "on the dorso-lateral angle.")

Hamites cylindraceus ? Defrance.

Plate 14, figures 2 and 2*a*.

Hamites cylindraceus, Defr.—D'Orbigny.—Pal. Franc., Terr. Cret., Vol. I., p. 551, Atlas, pl. 136.

Sucia Islands, in Division A.; J. Richardson, 1874.

A single specimen whose sculpture seems quite different to that of *Hamites Vancouverensis*, and which if not specifically identical with the *H. cylindraceus* as figured and described in the Paléontologie Française, and as since characterized by Pictet, cannot at present be distinguished from it. One side of both limbs of the fossil is worn away, and although the sculpture of a large portion of the test is well shewn, as are most of the details of the septation, still the specimen is not in a condition for the species to be determined with much certainty. Its faint, close set, equal ribs, which neither bifurcate nor bear tubercles, and more especially its septation, even to the shape and relative size of its smallest auxiliary lobes and saddles, are both almost exactly similar to those of *H. cylindraceus*.

Ptychoceras Vancouverense. (N. Sp.)

Plate 14, figures 3 and 3*a*.

Several specimens of the anterior, and apparently nonseptate, half of a Ptychoceras or Diptychoceras were collected by Mr. Richardson in 1871, from the Lower Shales, (Division B.) on the banks of the Trent River, V. I., above the falls. These for the most part consist of nearly the whole of the last limb and part of the last but one, with the elbow or shoulder which connects them. Immediately at the bend the limbs are scarcely two lines apart at their inner margins, and at a distance of rather more than an inch from it they touch each other. The outline of a transverse section of either limb is ovately-orbicular in most specimens, the anti-siphonal side being wider than the siphonal, but in some it is oval or ovate. The original of figure 3a, on Plate 14, appears to be a fragment of the central part of the penultimate limb, for the ribbing of the narrowest end is quite transverse, and that of the larger extremity nearly so.

The sculpture varies somewhat in different individuals and in different parts of the same shell. Both limbs are more or less strongly ribbed on the periphery and sides, but their inner surface is quite smooth. In the middle of the penultimate limb the ribs are transverse, but at and near

the shoulder or bend they are oblique; whereas on the last limb all the ribs are transverse. They are always most strongly marked at the point farthest from the aperture, and almost disappear just before reaching it. Thus, in the centre of the penultimate limb the surface markings appear as flattened, band-like, transverse constrictions and re-elevations, at close and regular intervals, and near the bend these gradually pass into oblique, raised and rounded rib-like folds, which are much narrower than the shallowly concave spaces between them. On the last limb the rib-like folds become fainter and more distant, until at last they fade away into a few irregularly disposed transverse raised striæ near the mouth, at a short distance from which there is a single, deeply concave, transverse groove or constriction. In some individuals the surface of the shell and cast of both limbs is also longitudinally and closely striated.

The largest specimen collected is rather more than six lines wide at the aperture, (from the siphonal to the antisiphonal side) but average examples are not wider than five lines at the same point.

The surface of *Diptychoceras lævis*, Gabb, from the "Shasta Group" of Cottonwood Creek, Shasta County, California, is said to be "plain, polished and marked only by a few extremely faint undulations," whereas in the present shell the ribs are both numerous and prominent, especially in the central portion of the penultimate limb.

This distinction may eventually prove to be only of varietal value, but for the present it will be most convenient to give the Vancouver shell a local name, as the rocks in which it is found are of later date than the Shasta Group.

Baculites Chicoensis, Trask.

Baculites Chicoensis, Trask.—Proc. Cal. Ac. Nat. Sc, 1856, p. 85, pl. 2, fig. 2.
" " Gabb.— Pal. Cal., Vol. I., p. 80, pl. 14, figs. 27, 29 and 29*a*, and pl. 17, figs. 27 and 27*a*.
Baculites inornatus, Meek.— Proc. Ac. Nat. Sc., Phil., 1861, Vol. XIII., p. 316.
Baculites Chicoensis, Trask?—Meek, Bul. Geol. & Geogr. Surv. of Terr., Vol. II., No. 4, p. 364, pl. 4, figs. 2 and 2*a*, *b*, *c*.

Vancouver and Sucia Islands, Meek. Lower Shales, Division B, of the south-west side of Denman Island. Productive Coal Measures, Division A., of the Sucia Islands (very abundant), and below Dodd Narrows, V. I. J. Richardson, 1872-75.

Baculites occidentalis, Meek.

Baculites ovatus (Say ?) Meek.—Trans Alb. Inst. 1857, Vol. 4, p. 48.
" *occidentalis*, Meek. —Proc. Ac. Nat. Sc., Phil., 1861, Vol. XIII., p. 316.
" " " Bul. Geol. & Geogr. Surv. of Terr., Vol. II., No. 4, p. 366, pl. 4, figs. 1, 1*a*, *b*.

Sucia Island, Meek. North-west side of Hornby Island, in Division D; J. Richardson, 1872.

A somewhat numerous series of Baculites obtained by Mr. Richardson at Hornby and at the Sucia islands, shows that the characters most relied on to distinguish these two so-called species are not constant. According to Mr. Meek, the outline of a transverse section of *B. Chicoensis* (or *inornatus*) is ovate, and the shell smooth, while in *B. occidentalis* the section is subtrigonal (the antisiphonal side being flattened) and the surface is undulating. Almost every intermediate gradation can be observed between shells with an ovate and those with a subtrigonal section, and further, it is not unusual to find specimens combining a smooth surface with a subtrigonal section, or a coarsely undulated test with an ovate section.

(Baculites compressus, Say.

Baculites compressus, Say. —1821, Am. Journ. of Sc. & Arts, Vol. II., p. 41.
" " Morton. —1834, Syn. Org. Rem. Cret. Gr. of U. S., p. 43, pl. 9, fig. 1.
" " Hall and Meek.—1854, Mem. Am. Ac. Arts & Sc., Boston, Vol. V., N. S., p. 400, pl. 5, fig. 2, and pl. 6, figs. 8 and 9.
" " Meek. —1876, Rep. Inv. Cret. and Tert. Foss. U. Miss., Co., p. 400, pl. 20, figs. 3*a*, *b*, *c*.

Baculites compressus is included by Mr. Etheridge in his list of Comox and Valdez Inlet fossils, but it has not been recognized in any of Mr. Richardson's collections, unless it is the same as one or both of the two preceding species or so-called species of Baculite, which is not at all unlikely.)

GASTEROPODA.

Surcula Suciensis. (N. Sp.)

Plate 15, figures 1, 1*a*.

Shell small, narrowly fusiform, very long and slender; spire elongated, turreted, nearly as long as the body whorl; beak attenuated, slightly curved. Whorls nine, those of the spire very gently convex, the lowest

ones subangular near the middle; suture rather indistinct. The three apical whorls are conical, and increase rather rapidly in width; the succeeding ones are more cylindrical, and widen much more gradually. Body whorl not quite half as wide as long; shallowly concave next the suture, at a short distance from which there is a blunt angle or shoulder, gently convex above the middle and rapidly narrowing below into a somewhat curved beak, which is much shorter than the spire. Outer lip with a broad, shallow sinus next the suture.

Surface ornamented by a minute net-work, produced by very numerous, crowded and minute impressed lines, and by equally numerous raised, flexuous, transverse striæ, which are parallel to the outer lip of the shell. In the penultimate whorl there are sixteen or seventeen revolving lines, which are placed at rather unequal distances, and both these and the transverse striations are so small as to be barely visible to the naked eye. Viewed at a short distance, without a lens, the surface has a shining, silky and almost pearly aspect.

Sucia Islands, in Division A.; J. Richardson, 1874. Four or five exquisitely preserved and almost perfect specimens.

The genera of *Pleurotomidæ* are very loosely and inaccurately defined, and it is generally admitted that the whole group needs revision. Until this has been done the proper position of the present species must be doubtful, though it seems to agree better with the characters of *Surcula* as now understood than with those of any other genus. It can scarcely be a *Pleurotoma* (or *Turris*), if either of these names is restricted to the large tropical or subtropical species, such as *P. Babylonica*, which have a deep and narrow infrasutural slit on the outer lip.

Surcula raricostata, Gabb, var.

Plate 15, figures 2, 2*a*.

Turris (sub-genus *Drillia*) *varicostata*, Gabb.—Pal. Cal., Vol. I., p. 93, pl. 18, fig. 47.
Surcula raricostata, Gabb ("*varicostata*, typogr. err.")—Id., Vol. II., p. 217.
Perhaps = *Fusus Renauzianus*, D'Orbigny.—Pal. Franc., Terr. Cret., Vol. II., p. 339, Atlas, pl. 223, fig. 10.

Middle Shales, Division D, West side of Hornby Island, one nearly perfect example; also Productive Coal Measures, Division A, of Nanaimo River, V. I., two and a half miles up, a single fragment; J. Richardson, 1872.

The Hornby Island specimen is rather more slender and less angular than the Californian types of *S. raricostata*, but the resemblances

between them are too close to admit of their separation into two species. The outer lip of the shell represented on plate 15 is broken, but its contour is plainly indicated by the lines of growth. Besides the distant, oblique, but nearly transverse ribs, the surface of the body whorl is finely striated across, and under the lens each of the striæ is seen to be curved concavely backwards near the suture so as to form a broad, shallow sinus. In the middle or a little above the middle of the last whorl, the striæ arch gently forwards, and below this they gradually straighten until they reach the base. Mr. Gabb makes no mention of these striæ of growth in his description of *S. raricostata*, and they are not represented in his figures of the species, so that it is to be presumed that they can only be seen in well preserved specimens. The minute curved lines of growth, and more especially the shallow sinus of the outer lip, appear to be the only characters by which this shell can be discriminated from the *Fusus Renauxianus* of the "Paléontologie Francaise," and these may not have been visible on D'Orbigny's specimens, which are not always as perfect as the figures might lead one to suppose.

Fulguraria Navarroensis, Shumard. (Sp.)

Plate 15, figures 3, 3*a*.

Volutilithes Navarroensis, Shumard.—Proc. Bost. Nat. Hist. Soc., 1861, Vol. VIII, p. 192.
" " Gabb.—Pal. Cal., Vol. I, p. 102, pl. 19, fig. 56.
Fulguraria Navarroensis, Stoliczka.—Gastr. Cret. Rocks of S. India, p. 86.
? = *Fulguraria elongata*, D'Orb. sp.—Compare especially Stoliczka's descriptions and figures of that species in the Paleontologia Indica, Vol. II., p. 87-89, pl. 7.

Middle Shales, Division D., of the west side of Hornby Island, one fragment; Lower Shales, Division B, at Blunden Point, (one); and Brown's River, V. I., (two); Productive Coal Measures, or Division A, of the Sucia Islands, ten large, well preserved and tolerably perfect examples; J. Richardson, 1871-74.

The Texan and Californian types of *V. Navarroensis*, described by Shumard and Gabb, appear to have been either young shells which had not yet begun to form the thickened outer lip and columellar callus, or else imperfect individuals in which those parts of the shell had been broken off. The Sucia Island Volutes, on the other hand, which clearly belong to the same species, are nearly all adult specimens, with comparatively thick tests, and with the mouth characters fully developed. Their outer lip is much thickened, though it can scarcely be said to be

reflected, and is continuous above with a flat, expanded, semiovate callus, which spreads over nearly the whole of the columellar side of the mouth and sometimes covers a small portion of the last whorl but one. At the junction of the outer with the inner or columellar lip there is a rather deep and sub-angular notch or "insinuation," whose centre is exactly in a line with the suture. There are three large, prominent, oblique, spiral plaits on the columella, which are parallel with each other, and about three lines apart at their summits. The upper or posterior plait is placed near the middle of the aperture, on its inner side, and the lowest, which is the least prominent of the three, is situated half way between the posterior plait and the base of the shell. On the body whorl the surface markings consist of eighteen or nineteen revolving raised lines or narrow ridges, which are interrupted and made nodulous by their being crossed by obscure and low, but rather broad, transverse folds, and coarse striæ of growth.

F. Navarroensis is probably only a varietal form of the *Voluta elongata* of D'Orbigny and other authors, which Stoliczka places in Schumacher's subgènus *Fulguraria*. The difference between the two nominal species practically amounts to this, that in some specimens of *F. elongata* the body whorl is more constricted posteriorly than it is known to be in *F. Navarroensis*, and that the transverse ribbing or plication of the surface is strongest in the former. A glance at Stoliczka's illustrations of Indian examples of *F. elongata*, however, will be sufficient to shew that these distinctions are not much to be relied upon as affording good specific characters. Nine individuals of this species are represented on Plate 7 of the second volume of the Palæontologia Indica, and four of these are not more constricted near the suture than the Sucia Island specimens of *F. Navarroensis* are. The insinuations of the striæ of growth, too, which Stoliczka says "are inseparably connected with the posterior constriction of the whorls," are very plainly visible in most of the Sucia Island Volutes, and the transverse plications of the surface in some Indian varieties of *F. elongata*, do not appear to be much more strongly marked than they are in average American individuals of *F. Navarroensis*.

The name *Volutilithes* has been used in such a wide sense by recent writers, that it has come to have about the same significance in Palæontology as the Linnæan genus *Voluta* has in Zoology. If used at all, the former name will probably have to be restricted to a group of more or less angular and spinous Eocene species, with feebly developed columellar folds, such as the *Voluta spinosa* of Lamarck, and the *V. luctatrix* of Brander. *Voluta elongata*, *V. Navarroensis*, and a number of closely re-

lated species, on the other hand, seem to form a well marked and very natural section, or subgenus of the *Volutinæ*, more characteristic of the Cretaceous than of the Tertiary rocks, whose shells can generally be distinguished without much difficulty by their slender, fusiform shape, their spirally striated or cancellated whorls, their thickened outer lip and comparatively prominent columellar folds.

Stoliczka, as before stated, holds that the name *Fulguraria* should be applied to these shells, on the ground that they do not differ in any essential particular from the type of that genus, the *Voluta fulminata* of Lamarck, and this view has been provisionally adopted by the writer. Conrad, it is true, says that *V. Navarroensis* belongs to his subgenus *Rostellites*,* but even if the correctness of this assertion be admitted, and the objection to its use, as suggesting affinities that do not exist, be waived, it still seems highly probable that *Rostellites* is merely a synonym of *Fulguraria*.

Fusus Kingii, Gabb.

Plate 15, figure 4.

Fusus Kingii, Gabb.—Pal. Cal., Vol. I., p. 85, pl. 28, fig. 204.

Sucia Islands, in Division A.; J. Richardson, 1874. Two specimens, both with most of the test preserved, but with the beaked extremity broken off. The best of these is figured, as the species was described from casts which did not shew the surface ornamentation. The sculpture consists of revolving ridges or fine rounded ribs, which are placed at unequal distances from each other, and these are crossed by crowded, minute and parallel, transverse, raised striations, also, on the angle or angles of the whorls only, by coarse distant plications. There are six or seven whorls; those of the spire are angular or subcarinated below the middle, and bear a single row of rather distant nodes or tubercles. The body whorl is concavely constricted near the middle, the constriction being bounded, both above and below, by a nodose and obtuse keel.

Serrifusus Dakotensis, var. Vancouverensis.

Plate 15, figure 5.

Fusus (Serrifusus) Dakotensis, Meek, var.—Rep. Inv. Cret. and Tert. Foss. U. Miss. Co., p. 375, pl. 32, fig. 7*a*.

Fusus (Serrifusus) goniophorus, Meek. —Idem, p. 376.

Shell large, subfusiform, angular; spire elevated, but not equal in height

* "American Journal of Conchology," Vol. I., 1865, p. 363.

to the body whorl: canal short. Whorls five and a-half or six, convex, angular, those of the spire obliquely compressed above and encircled below the middle by a narrow, very prominent, subnodose, laminar keel, beneath which they are nearly perpendicular, but slope a little inwards; sutures indistinct. Body whorl also obliquely flattened above, angular and keeled very conspicuously above the middle, ventricose, and bearing two minute keels or spiral ridges below, and finally contracting rapidly but unequally on either side into the short canal at the base. Aperture ovately subpyriform, broadly channelled in front; outer lip apparently thin and simple; pillar devoid of plaits, as far as can be ascertained; no callus on the columellar side.

The principal keel, which encircles the whole shell in a continuous spiral, is raised to a height of nearly, or quite, two lines above the highest general level of the whorls, and is subnodose, or undulated on its edge, in consequence of its being interrupted and crossed by slightly elevated transverse folds and corresponding shallow depressions, at irregular but for the most part rather distant intervals. In addition to this, the entire surface is covered by a fine and delicate network, composed of close-set minute, spiral raised lines, and of densely crowded, transverse, but somewhat flexuous striations.

Estimated length when perfect, about three inches and four lines; maximum width, one inch and not quite eleven lines.

Middle Shales, Division D, of the north-west side of Hornby Island; J. Richardson, 1872. A single specimen with the apex of the spire and tip of the canal broken off, but with a considerable portion of the test remaining, the sculpture of which is exquisitely preserved.

On pages 375-377 of his "Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country," plate 32, figure 7*a*, Mr. Meek has described and figured a *Serrifusus* from Dakota, which he provisionally regards as a varietal form of *S. Dakotensis*, but which he thinks may belong to a distinct, though closely allied species, for which he suggests the name *S. goniophorus*. Judging by the solitary specimen collected by Mr. Richardson, the differences between it and the Dakota shell do not appear to the writer to be sufficient to warrant their being regarded as two distinct species, but the Hornby Island *Serrifusus* is probably entitled to rank as a well marked variety, characterised principally by the much greater prominence of its revolving, spiral keel.

Perissolax brevirostris, Gabb.

Perissolax brevirostris, Gabb.—Pal. Cal., Vol. I., p. 91, pl. 18, fig. 43.

Sucia Islands, in Division A.; J. Richardson, 1874. One nearly adult and four or five immature specimens.

Littorina compacta, Gabb.

? Littorina compacta, Gabb.—Pal. Cal., Vol. I., p. 131, pl. 20, fig. 89.

Lower Shales, or Division B, of the south-west side of Denman Island; J. Richardson, 1871. Two perfect but small individuals.

Although no vestiges of any nacreous structure are apparent in the above named shells, yet, in the writer's judgment, their general appearance, thin test, and close resemblance to *Photinula*, suggest affinities with the *Trochidæ* rather than with the *Littorinidæ*. If the words "surface *smooth*," in Mr. Gabb's definition of the genus *Ataphrus*, were altered to "surface smooth or spirally grooved," the name of the present species could probably be better written *Ataphrus compactus*.

Potamides tenuis, Gabb.

Plate 15, figures 8, 8*a* and 8*b*.

Potamides tenuis, Gabb.—Pal. Cal., Vol. I., p. 130, pl. 20, fig. 86.

Middle Shales, Division D, north-west side of Denman Island, two nearly perfect and well preserved individuals. Lower Shales, Division B, south-west side of Denman Island, two small examples. Sucia Islands, in Division A., one very small and partly exfoliated specimen. J. Richardson, 1871-74.

In the description of this species no mention is made of the fine reticulation of the surface, so that it is to be presumed that Mr. Gabb's types did not show that character. In addition to the distant, elevated nodules on the angles of the whorls, the exterior of the test of *P. tenuis*, when in fine condition, is covered by a minute network, composed of crowded revolving striations, which are crossed by equally fine, transverse, flexuous striæ. A figure of the best specimen collected by Mr. Richardson has been given, as that in the Palæontology of California does not give a very good idea of the shape or sculpture of the species.

Potamides tenuis, variety Nanaimoensis.

Plate 15, figures 9 and 9*a*.

Shell turreted, very long and slender; whorls nine, increasing very gradually in size. The first five are convex, but somewhat compressed

at the sides; the sixth, seventh and eighth are also gently convex, but more or less angular or subcarinated a little below the middle. The body whorl is moderately inflated and faintly and spirally subcarinated considerably above the middle, and there is sometimes a second and smaller keel or ridge below the first. Tho aperture appears to have been obliquely subovate when perfect, and to have contracted suddenly below into a short, nearly straight, and channelled beak.

The surface is transversely ribbed and striated, and the lower whorls are also encircled by narrow, linear, revolving ridges. A large portion of the test on the body whorl happens to have been broken off in the few specimens yet collected, but on the last whorl but one the transverse ribs are distant, narrow and flexuous. On this whorl, too, and on that which precedes it, there are three rather widely separated revolving ridges above the angle, and four much more closely disposed ones below it. The summit of the angle also bears a single spiral ridge, which gives the shell a lightly carinated aspect, but the ridge on the angle is not larger nor more prominent than either of those above it. All the revolving ridges are marked by tubercles where tho ribs cross them, but the tubercles are largest on the angles of the whorls.

Middle Shales, Division D, of the north-west side of Hornby Island, three specimens; also Productive Coal Measures, Division A, at Nanaimo River, V. I., two miles and a-half up, two or three imperfect examples; J. Richardson, 1871 and 1872.

The spiral keel is not very distinctly defined in any of the specimens, and in some it is almost obsolete.

This shell is probably nothing more than a local variety of *P. tenuis*, which may usually be distinguished from the typical form by its slender and more elongated shape, more evenly rounded whorls, and by the numerous elevated revolving ridges on the two last volutions. The two forms, however, seem to be connected by intermediate gradations both of shape and sculpture.

Cerithium Lallierianum, D'Orbigny. Variety Suciense.

Plate 15, figures 10 and 10*a*.

Cerithium Lallierianum, D'Orbigny.—Pal. Franc., Terr. Cret., Vol. II., p. 365, Atlas, pl. 229, figs. 7–9.

" " *Forbes.* —Quart. Journ. Geol. Soc. Lond., Vol. I., p. 352, pl. 4, fig. 10.

Sucia Islands, in Division A., six well preserved examples; also Pro-

tection Island, in rocks of the same Division, a single and not very perfect individual; J. Richardson, 1872 and 1874.

The Sucia Island variety of *C. Lallierianum* differs only from the type of the species in its more ventricose whorls and deeper sutures.

Tessarolax distorta, Gabb.

Tessarolax distorta, Gabb.—Pal. Cal., Vol. I., p. 126, pl. 20, figs. 82 & 82 *a*, *b*.

Lower Shales, Division B, of the banks of the Trent River, V. I., below the falls; J. Richardson, 1871. One imperfect specimen.

Anchura stenoptera, Goldfuss. (Sp.)

Plate 15, figures 11 and 11 *a*.

Rostellaria stenoptera, Goldfuss.—Petrefactæ Germaniæ, Vol. III., p. 18, pl. 170, fig. 6.

Productive Coal Measures, Division A, Nanaimo River, V. I., two miles and a-quarter up; J. Richardson, 1872.

A single and rather imperfect individual, which appears to be identical with the above named European species. *A. stenoptera* was originally described from the "chloritic chalk" or Upper Greensand of Westphalia, and, according to Prof. Morris, it has since been found in the Lower Chalk of Sussex.

As there are some slight differences between the specimen collected by Mr. Richardson and the shell represented by Goldfuss, it has been thought desirable to give two figures of the former.

Anchura exilis, Gabb.

Aporrhais exilis, Gabb.—Pal. Cal., Vol. I., p. 129, pl. 29, fig. 231.
Anchura exilis, Gabb. —Idem, Vol. II., p. 226.

Productive Coal Measures, Division A, of the Sucia Islands; J. Richardson, 1874. One specimen.

Amauropsis Suciensis. (N. Sp.)

Plate 16, figure 1.

Shell ovately subglobose, longer than wide; spire about one-third the entire length. Whorls four or four and a-half, those of the spire conspicuously subtruncated or excavated next the suture above, obliquely but very gently convex, and somewhat compressed laterally below; suture deeply impressed. Body whorl inflated, narrowly rounded at the

base, and more or less distinctly shouldered or excavated, but not angular above; umbilicus small, but apparently never quite closed. Aperture sub-semicircular, pointed above, longer than wide, nearly straight, or with a slight sigmoid curve on the inner side, and regularly convex on the outer.

Surface nearly smooth, but marked with minute, densely crowded striæ of growth in well preserved individuals.

Length of the largest specimen yet obtained, six lines and a-half; height of the spire, two lines and a-half; maximum width of the body whorl, about five lines.

Productive Coal Measures, Division A, of Nanaimo River, V. I., two miles and a-half up, and of the Sucia Islands; J. Richardson, 1872 and 1874. One imperfect example from the first mentioned locality, and four well preserved specimens from the second.

Gyrodes excavata, Michelin. (Sp.)

Plate 16, figs. 2 and 2*a*.

Natica excavata, Mich., D'Orbigny.—Pal. Franc., Terr. Cret., Vol. II., p. 155, Atlas pl. 173, figs. 1 and 2.
Natica infracarinata, Gabb. —Proc. Ac. Nat. Sc. Phil., 1861, Vol. XIII., p. 319.
Gyrodes Spillmanii, Gabb. —Idem, p. 320.

Shell depressed subglobose, about as wide as high, spire short, less than one-fourth the entire length. Whorls four, those of the spire obliquely and gently convex, the third being also distinctly truncate above. Body whorl truncated nearly horizontally next the suture, concavely constricted immediately below the angle, which is subacute, and swelling out widely near or a little below it; base obliquely and somewhat concavely truncated on the inner side. Umbilicus widely and deeply funnel-shaped, with a distinctly carinated margin. Aperture triangular above, pointed below, longer than wide; outer lip thin, simple, and expanded in the centre; inner lip nearly straight, but curved somewhat concavely below. The truncation of the whorls above is concave in some specimens and flat in others.

Surface polished, nearly smooth, but marked with minute, numerous, and densely arranged curved striæ of growth.

The length and breadth of a perfect specimen are almost exactly equal, the greatest diameter being about six lines and a-half in either direction; the height of the body whorl is five lines.

Middle Shales, Division D, north-west side of Hornby Island, (one);

Lower Shales, Division B, at Brown's River, V. I. (one); Productive Coal Measures, Division A., at the Nanaimo River, ten miles up, (one); and Blunden Point, V. I. (two); also at the Sucia Islands, eight or ten specimens; J. Richardson, 1871-74.

This shell, which occurs at many localities in the Vancouver Cretaceous, is believed to be a small form of the European *Natica excavata*. Mr. Tryon, who has kindly compared two of the best specimens collected by Mr. Richardson with Mr. Gabb's types of *Natica infracarinata* from New Jersey and *Gyrodes Spillmanii* from Mississippi in the Museum of the Academy of Natural Sciences of Philadelphia, agrees with the writer in referring all three to *N. excavata*. *Gyrodes Conradiana* of Gabb,* from the Chico Group of California, is also probably another variety of the present species, in which the truncation of the upper part of the whorl is obsolete. The characters given above, though generally applicable, are subject to some variation, for in a specimen of *G. excavata*, from Brown's River, V. I., the whorls appear to be evenly rounded, or nearly so, above, and the umbilical keel is barely perceptible.

Sycodes glaber, Shumard. (Sp.)

Pyrula glabra, Shumard.—Trans. Ac. Sc., St. Louis, 1858, Vol. I., p. 125.
Ficus cyprœoides, Gabb. —Pal. Cal., Vol. I., (1864) p. 105, pl. 19, fig. 58.
Sycodes cyprœoides, Gabb.—Idem., Vol. II., pp. 160 and 121.

Productive Coal Measures, Division A, at Protection Island (four specimens), and Nanaimo River, V. I., two miles and a quarter up (two); also, Sucia Islands, (one); J. Richardson, 1872-74. "In dark limestone at Nanaimo River, with *Nautilus Dekayi* and *Inoceramus Vancouverensis*." Shumard.

Sycodes cyprœoides of Gabb is almost unquestionably the same shell as the *Pyrula glabra* of Shumard, and the latter specific name must be retained as having priority of date.

Hindsia nodulosa, Whiteaves. (Sp.)

Plate 15, figures 6 and 7.

Fasciolaria nodulosa, Whiteaves.—Geol. Survey of Canada, Rep. of Progr. for 1873-74, p. 268, pl. of fossils, figs. 7 and 7*a*, but not 7*b*.

Shell fusiform, sub-angular, about half as broad as long, spire rather more than one-third the entire length. Whorls seven, the first four more

* "Palæontology of California," Vol. I., p. 107, pl. 20, fig. 219

or less acutely conical, with obliquely flattened sides, the fifth and sixth concave above and swollen below into a prominent, narrowly rounded, nodulous, spiral ridge. Body whorl encircled in the middle by the same spiral ridge, broadly and concavely excavated above, and narrowing rather abruptly below into a stout, straight beak, whose length is nearly equal to that of the spire. Aperture ovately sub-triangular, angular or sub-angular near the middle on the outer and nearly straight on the columellar side; outer lip formed of a single flatly expanded varix, which is ribbed externally and crenulated within; inner lip encrusted, slightly convex above and straighter below, beak channelled, the channel open throughout its entire length; columella with four inconspicuous teeth or flattened tubercles at its upper end, and with three plaits or laminar teeth below. The teeth on the upper part of the columella are placed close together, the plaits or laminar teeth at its lower or anterior end, on the contrary, are comparatively far apart from each other. The first, or posterior plait, which is transverse and moderately prominent, is situated about the middle of the aperture, exactly opposite the angle of the outer lip; the second is rather more than a line in distance from the first; the position of the third, or anterior one, is not very clearly shewn, but it appears to be placed very near to the commencement of the canal. All the teeth and plaits are small, and situated so far back in the aperture that they can scarcely be seen, except in specimens in which part of the outer lip is broken away.

The entire surface is marked by numerous, simple, rounded, revolving raised lines, which are placed at varying distances apart, but which are always narrower than the flattened spaces between them. At least twenty-one of these revolving lines can be counted on the body whorl, and those below the central ridge are much larger than those above it. The spiral ridge or blunt keel, which encircles nearly the whole of the shell, is crossed, also, by distant, transverse, rounded, raised folds and corresponding depressions, but the folds are obsolete, or nearly so, both above and below the ridge, where the shell is simply striated across. The whorls of the spire, accordingly, are coronated below, and the body whorl bears about fourteen conspicuous, and transversely elongated but somewhat rounded nodes on its central blunt keel.

Two specimens of this species were collected by Mr. Richardson in 1872, one from the Nanaimo River, V. I., two and a half miles up, the other from Protection Island, both in Division A. These have been figured and briefly described in the "Report of Progress" for 1873-74, under the name

Fasciolaria nodulosa, but the apices of the spire, and the apertures of both were then completely buried in the rock, and the characters of the species were very imperfectly understood. The matrix has since been removed from both, and the spire has been found to be rather longer than it was first supposed to be; the aperture of one specimen, also, has been cleared sufficiently to expose the teeth and plaits on the columella; the presence of the latter was previously inferred from the shape and sculpture of the exterior. The outer lip of both is imperfect.

The original of figure 7 on plate 15, which was obtained by Mr. Richardson in 1874, at the Sucia Islands, from Division A., fortunately has the outer lip well preserved, and its expanded, varix-like shape shows that the shell belongs to the *Tritoniidæ*, rather than to the *Fasciolariinæ*.

There is no necessity for changing the specific name "*nodulosa*," although it was previously applied to a Miocene *Fasciolaria* from North Carolina by Dr. Emmons, in 1858, for the present species is almost certainly a *Hindsia*, in the sense in which that genus is now accepted by most palæontologists.

Cirsotrema tenuisculptum. (N. Sp.)

Plate 16, figures 3, 3*a*, 3*b* and 3*c*.

Shell elongate-conical; spire turreted, about equal in length to the body whorl; test thin. Whorls seven, those of the spire convex, with deep sutures; body whorl ventricose, with a small umbilical perforation at its base; aperture unknown.

Surface marked by minute, flattened, revolving ridges, which have a beaded aspect when viewed under a lens, in consequence of their being crossed by still more minute and crowded, transverse, raised lines. The revolving ridges are unequal in size, some being both broader and higher than others, but the larger ones are most numerous on the lower part of the upper whorls and on the middle of the last volution. There are about twelve of these ridges on the last whorl but one, five of which are larger than the rest, and on the body whorl there are about thirty, ten of which are comparatively large, and the remainder small. The transverse, raised lines extend from suture to suture. Near the middle of the outer whorl there is a narrow, very slightly elevated, transverse varix, or arrest of growth, which marks the position of a previous outer lip and to some extent indicates its outline.

Length of the only specimen not quite six lines; maximum convexity of the body whorl rather more than three lines.

Sucia Islands, in Division A.; J. Richardson, 1874.

Scalaria (Opalia) Mathewsonii, Gabb.

Scalaria (*Opalia*) *Mathewsonii*, Gabb.—Pal. Cal., Vol. I, p. 212, pl. 32, fig. 278.
Compare *Scalaria pulchra*, Sowerby.—Trans. Geol. Soc., Lond., 1836, series 2, Vol. IV. p. 343, pl. 18, fig. 11; and Geol. Mag., Lond. N. S., Vol. III., p. 109, pl. 8, fig. 14.

Productive Coal Measures, Division A., of the Sucia Islands; J. Richardson, 1875. An imperfect specimen with only parts of the test preserved, and with no indications of the basal carina remaining.

Margarita ornatissima, Gabb. (Sp.)

Angaria ornatissima, Gabb.—Pal. Cal., Vol. I., p. 121, pl. 20, fig. 78.

Middle Shales, Division D, north-west side of Hornby Island (one specimen.) Productive Coal Measures, Division A, of the Sucia Islands, abundant, perfect and well preserved; J. Richardson, 1872 and 1874.

This species is one of the most frequent and characteristic fossils of the Cretaceous rocks of the Sucia Islands. In the writer's judgment, it is a very typical *Margarita*, and Mr. W. H. Dall, who has seen the specimens, is of the same opinion.

Stomatia Suciensis. (N. Sp.)

Typical form, plate 16, figure 4. Variety *carinifera*, plate 16, figure. 5.

Typical form.—Shell subovate, longer than wide, pointed above and more or less narrowly rounded below; spire short, about one-fifth the entire length. Whorls four, increasing very rapidly in size, convex, oblique; sutures distinct. Spire turbinate conical; body whorl very oblique, moderately inflated, devoid of any umbilicus or umbilical depression, sometimes subangular near the base. Aperture ovate, longer than wide, pointed above and rounded below; outer lip thin, simple, gently convex; inner lip concave.

The surface of the last whorl is marked with rather fine, rounded, revolving ribs, which are wider than the impressed lines between them, and by coarse, irregularly disposed, transverse striæ of growth, some of which, in one specimen at least, are developed into nodular folds near the base of the shell.

Variety carinifera.—Shell wider than high; spire extremely low; body whorl obliquely compressed above, angulated below the middle,

and encircled with from one to four revolving keels in addition to the spiral ribs.

Sucia Islands, in Division A.; J. Richardson, 1874. Fourteen good specimens. Five of these belong to the typical form of the species and five to the variety *carinifera*, but the remainder, all of which are very small shells, form a connecting link between the two extremes, being wider than high as in the keeled variety, but resembling the type in the want of a prominent angle below the middle of the body whorl and in not being encircled by any revolving carinæ. The typical form grows to a considerable size; the largest individual (the original of figure 4, on plate 16), when perfect, was probably two inches and a half in length, but the largest example of the keeled variety yet obtained is not more than eight lines long. The large specimens, also, have had their original shape much altered by pressure.

It would seem that this is the only true *Stomatia* at present known from rocks of Cretaceous age. *Stomatia gaultina* of Pictet and Roux has been removed from that genus by Pictet & Campiche, and placed in *Neritopsis*, while the *Stomatia aspera* of D'Orbigny (Pal. Franc., Terr. Cret., Vol. II., p. 237, pl. 188, fig. 4–7) is almost certainly a *Catinus*.

Anisomyon Meekii, Gabb ? var.

Anisomyon Meekii, Gabb.—Pal. Cal., Vol. 1, p. 142, pl. 21, fig. 105.

Shell conical, moderately elevated, sides sloping obliquely in all directions, neither concave in front nor convex behind; base ovately-orbicular, a little longer than wide; apex acute, nearly erect but with a very slight inclination towards the posterior end, and situated a little in advance of the middle. Surface apparently marked with crowded concentric striations; muscular scars not visible.

Lower Shales, Division B, of the banks of the Trent River, V. I., above the falls; J. Richardson, 1871. Two large but imperfect and badly preserved casts, also a small but more perfect specimen with the test partly exfoliated.

On the posterior slope of the smaller of the two casts, a mesial carina runs from the apex to the base, as in the *Anisomyon borealis* of Meek and Hayden,* but no such keel is perceptible in the other two specimens. In the typical *A. Meekii*, from the Shasta Group of California, the apex

* See Meek's Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country, p. 288, pl. 18, fig. 9.

appears to be a little more hooked than it is in the *Anisomyon* from Vancouver Island, but at present no other appreciable difference can be noted between the specimens from these two localities.

Acmæa. (Sp. undt.)

Plate 16, figures 6 and 6*a*.

Compare *Acmæa Tejonensis*, Gabb.—Pal. Cal., Vol. II., p. 172, pl. 28, fig. 56.

Shell depressed conical, sides sloping obliquely and regularly in all directions; outline of base elliptical, but perhaps a little wider anteriorly than posteriorly; apex sub-central, situated slightly in advance of the middle, apparently conical and erect, not curved distinctly forwards. In a cast of the shell, when examined with a simple lens, the apex appears to be divided into two nearly equal halves by a minute, short, transverse, groove, and the anterior half is seen to be marked by two equally small and short longitudinal ridges. On the interior of the test, when viewed in the same way, a minute, transverse tubercle can be detected, which probably causes the transverse division of the apex visible in the cast, but the markings of the interior, which correspond to the longitudinal ridges on the anterior half of the cast of the apex, cannot be clearly made out.

On each side of the interior of the test and of the outer surface of the cast there is a curved, oblong, muscular scar, whose outline is very similar to that of a bean, except that it is obliquely truncated behind. At the posterior end these two scars are distinctly connected by a nearly straight, rather broad band, which unites with the inner half of their truncated ends. In front, also, the two lateral scars seem to be connected, but very obscurely, by an ill-defined, narrow, irregular, but somewhat semielliptical line of attachment either of the muscles or of the mantle.

The sculpture of the exterior is unknown, and the outer surface of the apex has not been seen, but radiating and rather broad bands of colour are more or less visible on the interior of the test.

Nanaimo River, V. I., two miles and a quarter up, in Division A; J. Richardson, 1872. A single specimen, broken into two halves, in one of which the whole of the interior of the shell is exposed, the outer surface being covered by rock, while the second is a beautifully preserved cast of the first.

It is quite likely that the fossil above described may be an adult individual of *Acmæa Tejonensis* Gabb, but until its characters are better known

it would be useless to speculate on its possible specific relations. Its muscular scars are very different to those of *Anisomyon alveolus* of Meek and Hayden, which it closely resembles in other respects.

Cinulia obliqua, Gabb.

Cinulia obliqua, Gabb.—Pal. Cal., Vol. 1, p. 111, pl. 19, figs. 64, 64*a*, *b*, *c*.

Middle Shales, Division D, of the north-west side of Hornby Island. Lower Shales, Division B, of the south-west side of Denman Island. Productive Coal Measures, Division A, at Nanaimo River, V. I., two and a-half miles up, at Protection, Gabriola and Salt Spring or Admiralty Islands, also at the Sucia Islands. Apparently the most abundant gasteropod of the Nanaimo and Comox coal fields, as it was met with in almost every locality examined by Mr. Richardson.

Cinuliopsis, New Genus.

Shell like that of *Cinulia*, Gray, as recently re-defined by Meek,* but with the aperture distinctly notched or rather deeply sinuated in front, also with the outer lip not thickened externally.

The affinities of this genus are at present doubtful. Its proper place may possibly be in the family *Ringiculidæ*, between *Ringicula* and *Cinulia* proper, but the emargination of the aperture in front, which indicates the probable existence of a respiratory siphon or siphonal fold in the animal, seems to point to a nearer relationship with the *Siphonostomata* than with the *Holostomata*. In *Cinulia* the anterior margin of the aperture is entire or nearly so, and the outer lip is much thickened.

Cinuliopsis typica. (N. Sp.)

Plate 16, figures 7, 7*a* and 7*b*.

Shell ovately subpyriform, spire very short; body whorl ventricose in the middle and narrowing somewhat rapidly below. Aperture elongated, much longer than wide, broadly convex on the outer and nearly straight on the inner side. Columellar lip spreading into a thick, broad, rounded callus above, contracted in the middle, narrow and produced below. Columella bearing a single, rather prominent and very oblique spiral fold near its anterior termination, into which it ultimately merges. Outer lip simple, continuous with the columellar callus above, deeply channelled and emarginate at its junction with the columella below. When the shell

*Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country, p. 288.

is placed with its aperture downwards, the canal is seen to be obliquely recurved, and its previous position is indicated by an oblique groove, bounded above by a raised, rounded ridge, both of which take their rise from the outer margin of the columella, a little below the middle of the aperture. The groove leads directly into the channel, while the ridge, which bounds both on one side, terminates at the base of the outer lip.

The surface is marked by squarely cut, revolving grooves, and by minute, crowded, transverse striations. On the body whorl there are about fourteen or fifteen spiral grooves, those in the central portion being about as wide as the interspaces, while those near the suture above and base below are almost invariably wider than the spaces between them.

Productive Coal Measures, Division A., of the Sucia Islands; J. Richardson, 1875. A nearly perfect specimen in very good condition. The apex is broken off, so that it is impossible to say whether the spire was obtuse or abruptly acuminate, but there can be no doubt that it was extremely short.

Haminea Horni, Gabb? var.

Plate 16, figures 8, 8*a* and 8*b*.

Bulla Hornii, Gabb.—Pal. Cal., Vol. I., p. 143, pl. 29, fig. 235.

Middle Shales, Division D, of the north-west side of Hornby Island. Lower Shales, Division B, of the south-west side of Denman Island. Productive Coal Measures, or Division A, at Blunden Point, and two miles and a quarter up the Nanaimo River, V. I., also at Vesuvius Bay, Admiralty Island, and at the Sucia Islands. J. Richardson, 1872-75.

Fifteen or sixteen well preserved specimens of a small species of *Haminea*, which seem to possess essentially the same characters as the Tejon fossil described by Mr. Gabb as *Bulla Hornii*. In addition to the "very fine, impressed, revolving lines" by which the surface of that shell is said to be marked, the test of the best specimens collected by Mr. Richardson is densely and very finely striated transversely, and the impressed lines, under a simple lens, are seen to consist of continuous, rounded punctures. When still more highly magnified the lines appear to be regularly crenate on both sides, as shown in the figure.

The length of the largest specimen is not more than four lines.

Dentalium Nanaimoense, Meek.

Plate 16, figures 9, 9*a*, and 9*b*.

Dentalium Nanaimoense, Meek. —Trans. Alb. Inst., Vol. IV., (1857) p. 44.

" *Kosmooksense*, Meek. —Bul. Geol. & Geogr. Surv. of Terr., Vol. II., No. 4, p. 364, pl. 3, fig. 6.

? = *Dentalium stramineum*, Gabb. —Pal. Cal., Vol. I., p. 139, pl. 21, fig. 101.

Compare *Dentalium gracile*, Hall & Meek.—See Meek's Rep. Inv. Cret. and Tert. Foss. of the U. Miss. Country, p. 266, pl. 18, figs. 13, *a*, *b*, *c*, *d*.

Also, *Dentalium decussatum*, Sowerby. —Especially as described and figured by J. Starkie Gardner in the Feb. No. 1878, of the Quart. Journ. of the Geol. Soc. of London.

Denman Island, south-west side, in Division B. Two miles and a-quarter up the Nanaimo River, V. I.; also Admiralty Island and the Sucia Islands, in Division A.; J. Richardson, 1872-75.

Dentalium Nanaimoense was described from a fragment of the anterior portion of the shell not much more than half an inch in length, and the species has since been found to taper much more gradually than it is represented as doing in Meek's partly restored figure. Although none of the specimens collected by Mr. Richardson are perfect, especially at the larger end, yet some of them are more than an inch long, and the relative width of fragments of both extremities seems to indicate that the shell attained to a length of two inches or more. It is slightly curved and very slender, the apical portion in particular being extremely narrow and attenuated. The thickness of the anterior end of the largest individual yet obtained is not much more than two lines. In a specimen fourteen lines long, from the Sucia Islands, the apex, which is imperfect, is about a quarter of a line in diameter, and the anterior end rather more than a line, but others are more robust. The longitudinal ribs commence at the apex and extend to within a very short distance of the mouth. In the original of figure 9*b*, on plate 16, there are about sixteen costæ near the smaller end, and at the opposite extremity they have increased to double that number by the intercalation of a shorter rib between each pair of the longer ones. The test is moderately thick, and the transverse striæ are extremely faint and disposed at rather irregular intervals.

Mr. Meek says, "This species is nearly related to *D. gracile*, of Hall and Meek, from which it may be distinguished by its thinner shell and

more slender form, as well as by its less distinct lines of growth." Both shells, however, were described from imperfect specimens, and under the circumstances, these differences, which after all are only differences of degree, are perhaps not much to be relied upon for the discrimination of closely allied species. Meek's latest description of *D. gracile* would apply almost equally well to *D. Nanaimoense*, and the same may be said of the brief diagnosis of *D. stramineum* in the first volume of the Palæontology of California, though it is only fair to both writers to add that they may have had reasons for regarding their species as distinct from the present, which are not fully stated in their definitions of the former. It is by no means improbable, too, that *D. gracile*, *D. Nanaimoense* and *D. stramineum* are only geographical and varietal forms of the *D. decussatum* of Sowerby.

Entalis Cooperi, Gabb. (Sp.)

Plate 16, figures 10 and 10*a*.

Dentalium Cooperi, Gabb.—Pal. Cal., Vol. I., p. 139, pl. 29, fig. 100.

Shell, when full grown, very large, slightly curved; section circular or nearly so; test extremely thick in the middle and at the smaller end. Surface marked by a faint and very minute reticulation, barely visible to the naked eye, and produced by minute, parallel, transverse grooves or annulations, which are crossed at right angles by still finer and fainter, longitudinal, impressed lines. In very young specimens the test is quite thin and the reticulation of the surface is barely perceptible, even when examined with a lens.

North-west side of Hornby Island, in Division D; two miles and a quarter up the Nanaimo River and lower part of the Trent River, V. I., in Division A; J. Richardson, 1872 and 1873. The specimens from the Trent River show that the species must have been very large when perfect, for one shell from this locality, the original of figure 10 on plate 16, measures more than three inches and three-quarters in length, and wants nearly three-quarters of an inch of the smaller end. Nearly all the large specimens are much distorted by pressure, but in a single fragment of the posterior half of the shell, an inch and three-quarters long, which seems to have preserved its normal shape, the small end is fully two lines in diameter and the large nearly four. At the posterior end, therefore, the diameter of the shell appears to become doubled in a length of two inches, but the rate of increase towards the anterior end of adult shells seems to have been less rapid.

LAMELLIBRANCHIATA.

Teredo Suciensis. (N. Sp.)

Plate 17, figures. 1, 1*a*.

Shell globosely cordate; valves very inequilateral, slightly longer than high; test thin. Anterior side short; anterior auricle convex above, pointed in front, truncated almost horizontally below, variable in size, but usually very small. In six out of seven specimens the anterior auricle extends from the beaks to one-third the distance from the extremity of the ventral border, but in the seventh it reaches as far downwards as the middle of the front margin of the valves. Anterior hiatus, as viewed in front, inversely triangular, higher than wide in the majority of specimens, but in one instance only, wider than high. Margin of the valves, as viewed laterally, truncated almost perpendicularly, but a little obliquely, beneath the anterior auricle. Base obtusely pointed, posterior side longer than the anterior, nearly straight above, narrowing obliquely and concavely from the base upwards, gaping rather widely in its lower half and forming a bluntly pointed or narrowly rounded junction with the cardinal margin above. Umbones prominent, placed in advance of the middle; beaks incurved and directed a little forwards.

The valves are divided into three subordinate areas, each of which has its own peculiar shape and style of sculpture. The first of these is the anterior auricle, whose surface is covered with densely crowded and exceedingly minute, concentric striæ which can only be seen by the aid of a lens. The second is the central area, which is very narrow and invariably marked by minute radiating striæ barely visible to the naked eye. Its upper portion lies between the posterior area and the anterior auricle, from which latter it is sometimes separated by an impressed line or slight shoulder, and below the auricle it occupies the narrow space between the posterior area and the front margin of the valves. It is widest in the middle and diminishes very gradually in size both above and below. The third, or posterior area, is much larger than the two others combined and includes the whole of the shell behind the central area. Two very faint, shallow grooves, with a small and equally faint, linear rib between them, extend obliquely from the beaks to the middle of the pointed base, and these together form the front boundary of the posterior area and mark its separation from the central space. The

sculpture of the posterior area consists of concentric, raised striæ or fine ribs, which follow the curved outline of the shell, and in doing so bend downwards, and again a little upwards at an obtuse or somewhat rounded angle in crossing the farthest of the two grooves from the central space. In some specimens the raised striæ on the posterior area are much wider than the spaces between them, and the surface of these may fairly be called ribbed, but even in those individuals which are most finely striated the striæ on the posterior area are always perceptibly coarser and farther apart than they are on any other part of the shell.

Burrows cylindrical, lined with a calcareous tube, which is variously bent or curved when the shell is immature, but which becomes nearly straight when the animal has attained its full size. The surface of the posterior end of the tube, also, is marked by rather faint, but broad, swellings, which alternate with obscure, narrow constrictions at irregular intervals, and its closed termination anteriorly is subtruncated, with the edges slightly bevelled off.

South-west side of Denman Island, in Division B; J. Richardson, 1872. Sucia Islands, in Division A; J. Richardson, 1874. Tubes also, which may belong to this species, were found at the east end of Denman Island, in Division C, but no shells have been found in them, and the specimens may have been derived from the underlying shales of Division B.

An interesting and very curious species, of which only seven detached valves have been obtained, none of which are quite perfect. In some respects *T. Suciensis* comes very near to *T. partita*, *T. crassula* and *T. torulosa* of Stoliczka,* from the Cretaceous rocks of Southern India, but at present it cannot be satisfactorily identified with either. The delicate surface markings of the valves of *T. partita* and *T. torulosa* appear to differ from those of *T. Suciensis* in more than one particular. Thus the central area of *T. partita* is separated from the posterior side by a single deep groove, and the striations of its whole surface are described as being "extremely fine, so much so that they are often barely traceable." As already pointed out, there are two faint, shallow grooves with an obscure ridge between them on the anterior boundary of the posterior area in *T. Suciensis*, and in that species the striations or fine ribs on the same area are very strongly marked. In *T. torulosa* there is stated to be a single wide groove between the central and posterior areas, and its central area is described as being wide, whereas it is very narrow in *T. Suciensis*. So far as the sculpture alone is concerned, there are several

* Cretaceous Pelecypoda of Southern India, pp. 15 and 16, pl. 1, figs 1, 2, and 8.

points in which *T. crassula* resembles the present species. The most noticeable of these are, first, that both have two furrows or grooves, which, to use Stoliczka's words, "run along the greatest convexity from near the apex to the periphery," and, secondly, that the anterior auricle of both is minutely striated. But, on the other hand, the striæ on the posterior auricle of *T. crassula* are stated to be finer than those on the median area, the opposite being the case in *T. Suciensis*, and further, if Stoliczka's figure be correct, which there is no reason to doubt, the height of the valves of *T. crassula* is greater than their length, whereas in *T. Suciensis* the shell is certainly longer than high.

Martesia clausa, Gabb.

Plate 17, figures 2, 2*a* and 2*b*.

Martesia clausa, Gabb.—Pal. Cal., Vol. I., p. 145, pl. 22, fig. 115.

Productive Coal Measures, Division A, of North West Bay, V. I.: J. Richardson, 1871. Several very perfect specimens boring into fossil wood.

The Vancouver Island variety of *Martesia clausa* is more elongated than the type of the species figured in the "Palæontology of California," and its double umbonal groove is much narrower. The umbonal groove of the Californian shell is said to widen rather rapidly below, but in Mr Richardson's specimens there is an exceedingly narrow, linear, flattened ridge, scarcely any wider at the ventral margin than near the beaks, with a shallow groove on each side of it. The calcareous filling up of the anterior gap, or foot opening, appears to be divided in a line with the opening of the valves; it is much swollen and projects somewhat beyond the front margin of the valves. The umbonal accessory valve or plate is preserved in two of the specimens from North West Bay: its outline is broadly oval, the width being greater than the length, and in front, between the beaks, it is developed into a small rounded lobe. Along its centre there is a longitudinal line, which divides the plate into two nearly equal portions, but the dividing line is a little sinuous posteriorly, and may possibly have been caused by an accidental fracture. It cannot at present be positively stated that the umbonal valve or plate is divided longitudinally in its normal state, but if such should prove to be the case the species would agree better with the definition of *Parapholas* that with that of *Martesia*. Stoliczka, however, says that the distinction between these genera, which is based principally on the division or non-division of the umbonal plate, "scarcely deserves

to be regarded as of generic value,* as has already been stated on page fifty-five of the present volume.

Corbula Traskii? Gabb.

Plate 17, figure 3.

Corbula Traskii, Gabb.—Pal. Cal., Vol. I., p. 149, pl. 22, figs. 121 and 121*a*.

Middle Shales, Division D, of the north-west side of Hornby Island; J. Richardson, 1872. Three imperfectly preserved right valves.

The specimens are in such poor condition that their determination is far from certain, still they are so much like Mr. Gabb's figures of *C. Traskii* that their identity with that species is highly probable. The test of these three *Corbulæ* from Hornby Island is more or less coarsely and irregularly striated, rather than costate, but the sculpture of some Cretaceous species of *Corbulæ* is known to be variable. Thus the valves of *C. pyriformis*, Meek, good examples of which were collected by Mr. Selwyn in 1875, at Pine River Forks, and on the Upper Peace River, in British Columbia, are indifferently either finely striated or coarsely ribbed.

Corbula minima, D'Orbigny.

Plate 17, figures 4 and 4*a*.

Corbula minima, D'Orb. Stoliczka—Cret. Pelecyp. S. India, p. 44, pl. 1, figs. 19-22, and pl. 16, figs. 7–12.

Same locality, division and collector as the last; one right and one left valve, both nearly perfect and well preserved.

The Californian analogue of this species is *C. Hornii* of Gabb, which is possibly the same shell as the *C. truncata* of D'Orbigny, but not of Sowerby. *C. minima* has a flatter shell than *C. Hornii;* the posterior end of the former is not so much elongated as it is in the latter species, and in *C. minima* there is an acute umbonal ridge on the posterior end of both valves, which is wanting on the right valve of *C. Hornii*.

Periploma suborbiculatum. (N. Sp.)

Plate 17, figure 6.

Shell inequivalve and inequilateral, compressed at the sides, but somewhat tumid in the umbonal region; test very thin, posterior margin of the valves curved a little to the left; length slightly greater than the height. Outline subcircular, the lower half of the margin of the valves, in particular, being regularly rounded; superior border sloping convexly

* Cretaceous Pelecypoda of Southern India, p. 24.

and very gently downwards in front, descending abruptly and somewhat obliquely, but not convexly, behind: posterior side very short and contracted; beaks small, curved backwards, not much elevated, placed distinctly behind the middle; umbo apparently fissured, the fissure narrow, slightly curved, and extending from the beaks about half-way across the valves. Behind the umbonal fissure, and in the centre of the space between it and the posterior margin, there appears to be a second, but much shorter, impressed line.

Surface marked by irregularly disposed, concentric striæ of growth.

Length, nine lines; height, eight lines and a quarter.

Nanaimo River, V. I., two miles and a quarter up, in Division A; J. Richardson, 1872. A single perfect specimen, with both valves in apposition. The left valve is partly buried in the rock, but it appears to be the most convex of the two. The impressed line on the umbones may indicate an acute, raised lamina on the inner surface of the valves, rather than an umbonal fissure.

Anatina sulcatina, Shumard.

Plate 17, figures 5 and 5*a*.

Anatina sulcatina, B. F. Shumard.—Proc. Boston Nat. Hist. Soc., 1861, Vol. 8, p. 204.

Sucia Islands, in Division A; J. Richardson, 1875. Three fine specimens.

The following is Dr. Shumard's description of *Anatina sulcatina*:—

"Shell large, ovate, thin, inequivalve, very inequilateral: *length not quite equal to the width;* anterior end broadly rounded; posterior end short, contracted, narrowly rounded; pallial margin gently convex; beaks small, but little elevated, situated posterior to the middle; cardinal margin straight, or very slightly convex before the beaks, and very slightly arched behind; a narrow, distinctly impressed, and very gradually expanding sulcus, extending from beak to pallial margin, which it cuts a little behind the middle; surface with from twenty to twenty-five rounded, concentric folds, becoming indistinct on the posterior part of the shell. There are also many fine, concentric lines of growth visible to the naked eye."

"Length, 3½ inches; width, 1½ inches; thickness, 6½ lines."

"Ripley Group, Chatfield Point, Navarro County," Texas.

The measurements show that the length is rather more than twice the width or height, and the words italicized in the above diagnosis are, therefore, obviously incorrect. The transverse groove or sulcus, which

Dr. Shumard says is "distinctly impressed" in the types from Texas, is broad, shallow and obscure in the Sucia Island specimens, but these latter are all more or less distorted by lateral compression.

ANATINA TRYONIANA, GABB.

Anatina Tryoniana, Gabb.—Pal. Cal, Vol. I., p. 150, pl. 29, fig. 240.

Lower Shales, Division B, at Gabriola Island; J. Richardson, 1872. One specimen with both valves preserved, but with a small portion of the posterior end broken off.

(ANATINA QUADRATA, GABB.

Anatina quadrata, Gabb.—Pal. Cal., Vol. II., p. 177, pl. 29, fig. 64.

"From the greenish rock on the north shore of Departure Bay, Nanaimo, Vancouver Island; associated with *Pecten Traskii*, *Trigonia Evansana* and other species characteristic of the Chico Group of California." Gabb. Possibly an elongated form of *Thracia subtruncata*, Meek, but if not it has not been detected in any of Mr. Richardson's collections.)

THRACIA SUBTRUNCATA, MEEK.

Plate 17, figure 7.

Thracia? subtruncata, Meek.—Trans. Alb. Inst., 1857, Vol. IV., p. 44.

" " " Bul. Geol. & Geogr. Surv. of Terr., Vol. II., No. 4, p. 363, pl. 2, figs. 4 and 4*a*.

Nanaimo, V. I. Meek. Sucia Islands, in Division A; J. Richardson, 1874. One tolerably good specimen.

PHOLADOMYA ROYANA, D'ORBIGNY.

Pholadomya Royana, D'Orbigny, —Pal. Franc., Terr. Cret., Vol. III., p. 360, pl. 367.

Pholadomya subelongata, Meek. —Trans. Alb. Inst., 1857, Vol. IV., p. 41.

" " —Bul. Geol. & Geogr. Surv. of Terr., Vol. II., No. 4, p. 362, pl. 2, figs. 1 and 1*a*.

Pholadomya Breweri, Gabb. —Pal. Cal., Vol. I., p. 152, pl. 22, fig. 123.

Nanaimo, V. I., and Newcastle Island. Meek. (*P. subelongata*.) Gabriola Island, in Division B (two specimens); Sucia Islands, in Division A (one specimen); J. Richardson, 1872 and 1874.

A critical comparison of the description and figures of *P. Royana* with those of *P. subelongata* has led to the conclusion that the two shells are identical. Both have the same transversely elongated, slightly curved elliptical outline: the beaks of each are subterminal, and the radiating ribs of both are acute, and become nearly obsolete at the posterior and

anterior end. The number of ribs, also, is variable in both; Meek says there are from sixteen to twenty-five in *P. subelongata*, and D'Orbigny figures two extreme forms of *P. Royana*, one of which has ten ribs and a half, and the other twenty-nine. The Gabriola Island specimens of *P. Royana* have the beaks placed at a considerable distance from the anterior end, and the length of their shells is not, proportionately, so great as is that of the type of *P. subelongata*. In the latter respect they approach very near to *P. Brewerii*, Gabb, which appears to be only a short variety of *P. Royana*.

HOMOMYA CONCENTRICA, GABB.

Panopæa concentrica, Gabb.—Pal. Cal, Vol. I., p. 148, pl. 22, fig. 119.
Homomya concentrica, Gabb.—Id., Vol. II., p.p. 179 and 236.

Sucia Islands, in Division A; J. Richardson, 1874. Two specimens: the largest and most perfect four inches and a-half in length, three inches in height, and two inches and two lines in thickness through the closed valves. The test is marked by coarse, irregular, concentric plications and more or less fine striæ of growth, but it can scarcely be said to be ribbed.

(GONIOMYA BOREALIS, MEEK.

Pholadomya (Goniomya) borealis, Meek.—Trans. Alb. Inst., Vol. IV., (1857) p. 41.
Goniomya borealis, Meek. —Bul. Geol. & Geogr. Surv. of Terr., Vol. II., No. 4, p. 362, pl. 2, fig. 2.

Nanaimo, Vancouver Island. Meek. Not in any of Mr. Richardson's collections.)

CYMBOPHORA ASHBURNERII, GABB.

Plate 17, figure 8.

Mactra Ashburnerii, Gabb.—Pal. Cal., Vol. I., p. 153, pl. 22, fig. 127. Ribbed variety only.
Cymbophora Ashburnerii, Gabb.—Id., Vol. II., p. 181, pl. 29. fig. 69.

Middle Shales, Division D, of the north-west side of Hornby Island; Lower Shales, Division B, at Gabriola Island; Blunden Point, V. I., Protection and Sucia Islands, in Division A. J. Richardson, 1871-75.

The hinge teeth are not exposed in any of the specimens from the above mentioned localities, but the sculpture of the exterior of the shell is very different to that of any other species of *Mactra* from the Cretaceous rocks of North America, and accords perfectly with Mr. Gabb's description of the ribbed variety of *C. Ashburnerii*. The central area of the valves is ornamented with large, prominent, rounded and rather regular,

concentric ribs, which are usually much wider than the deep, narrow grooves between them. On the lunule and escutcheon the ribs are small, narrow and acute, and commence at the superior border both in front and behind as simple raised lines.

The specific characters of this shell are very nearly the same as those of a *Mactra* from the Cretaceous rocks of Southern India, described by Professor Forbes under the name *Mactra tripartita*, G. B. Sowerby, MSS.* Stoliczka says that the central area of *M. tripartita* is divided from the lunule by a narrow groove, and from the escutcheon by a broad, shallow sulcus, neither of which are to be seen in any of the specimens collected by Mr. Richardson, but these markings are not mentioned in Forbes' description of *M. tripartita*, nor are they indicated in either of Stoliczka's figures of that shell.

MACTRA (CYMBOPHORA ?) WARRENANA, MEEK & HAYDEN.

Plate 17, figure 9, and plate 19, figures 3 and 3*a*.

Mactra Warrenana, Meek & Hayden. —Proc. Ac. Nat. Sc., Phil., Vol. VIII. (1856), p. 271.

Mactra (Cymbophora) Warrenana, Meek.—Rep. Inv. Cret and Tert. Foss. U. Miss. Co., p. 208, pl. 30, figs. 7, *a*, *b*, *c*, *d*.

Collected by Mr. Richardson at the same localities and from the same divisions as the preceding species, also at Newcastle Island, and two miles and a half up the Nanaimo River, V. I., in Division A.

The specimens have been compared with authentic examples of *M. Warrenana* from Dakota, received from Mr. Meek, and no appreciable differences could be perceived between them.

The present shell may be the same as the smooth form of *C. Ashburnerii*, but Mr. Gabb's description of the latter embraces such a wide range of variation that there are few species of *Mactra* from the Cretaceous rocks of North America to which it would not apply. Conrad claims† that two species have been confounded together under the name *C. Ashburnerii*, one of which is strongly ribbed, and the other marked only by fine lines of growth, but he is certainly mistaken in the supposition that the latter is an Eocene fossil. In the Vancouver Cretaceous these smooth Mactras may be distinguished at a glance from the large and coarsely ribbed variety of *C. Ashburnerii*, with which they are almost invariably found associated, by their smaller size, more decidedly triangular outline, and, more especially,

* Transactions of the Geological Society of London, Series II., Vol. VII., p. 142, pl. 15, fig. 17.
† American Journal of Conchology, Vol. I., p. 364.

by their peculiar and apparently constant sculpture, which is not very well represented in the figure on plate seventeen.* The surface is marked by from one to three faint, shallow grooves, or arrests of growth, which extend from margin to margin. When there are three of these grooves, which there generally are in adult shells, the first and second are wide apart, and the second and third comparatively close together. In addition to these markings, the central area of the valves, though polished and apparently smooth, or nearly so, to the naked eye, when examined with a lens is seen to be covered with regularly arranged, crowded and minute concentric striæ. On the lunule and escutcheon these striæ are developed into prominent, rather distant, rib-like ridges, which are plainly visible without the aid of a magnifying glass. So far as the surface markings are concerned no intermediate gradations have as yet been observed between these finely striated and coarsely ribbed shells.

M. Warrenana appears to be closely allied to the *M. angulata* of Sowerby,† but the description of the latter shell is too short and insufficient to allow of an accurate comparison between the two species.

Tellina (Peronæoderma?) Mathewsoni, Gabb.

Tellina Mathewsoni, Gabb.—Pal. Cal., Vol. I., p. 158, pl. 23, fig. 136.

Nanaimo River, V. I., two miles and a half up, in Division A; J. Richardson, 1875. A somewhat imperfect cast with portions of the test preserved. Mr. Gabb says that the beaks of this species are central, but in his figure of the shell they are represented as slightly behind the middle. In the specimen from Vancouver Island their position is distinctly behind the middle.

Tellina (Œne?) Sp. Undt.

Plate 17, figure 10.

Shell small, much compressed, transversely and narrowly sub-elliptical, about twice as long as high, test extremely thin. Extremities narrowly rounded, the posterior being rather narrower than the anterior; anterior side produced, elongated; posterior side short. A small posterior area is very obscurely indicated by an abrupt and obliquely convex compression of the valves behind and above a line which might be drawn from the rear of the beaks to the base, but the umbonal ridge is not very

* As this figure has not proved satisfactory, two additional illustrations of the species have been given on plate 19.

† Transactions of the Geological Society of London, Series II., Vol. IV., (1836) p. 341, pl. 16, fig. 9.

distinct or well defined in the upper half of the shell, and disappears entirely in the lower. Beaks very small, not much elevated, pointing backwards and placed a little behind the middle. Dorsal margin sloping in both directions from the beaks; the posterior slope descending obliquely and rather rapidly; the anterior straighter and more nearly horizontal. Ventral border nearly straight for the greater part of the length, but rounding upwards at the anterior end. Hinge teeth and muscular impressions unknown.

Surface marked by exceedingly fine and delicate concentric striæ, or crowded lines of growth.

Length, about three lines and a half; height, not quite two lines.

Vesuvius Bay, Salt Spring or Admiralty Island, in Division A; J. Richardson, 1875. A detached left valve.

This fragile and glassy little shell appears to be undescribed, but as the only specimen collected is an imperfect valve, probably of an immature individual, it is not thought desirable to give it a new specific name. It is rather closely allied to *T.* (*Œne*) *subscitula*, Meek,* but is more narrowly elongated, has smaller and less elevated beaks, a much straighter ventral margin, and no trace of any flexure on the posterior side. In the general outline of its valves it seems to approach rather nearly to *Œnona papyria* of Conrad,† but the latter shell is described as "convex," and its ventral margin is said to be "regularly curved." Moreover, one of the characters of the subgenus *Œnona* is its very narrow, lanceolate lunule, marked by a deeply impressed line, while no indications of any definitely margined lunule can be detected in the present species.

Tellina (Palæomœra ?) quadrata, Gabb.

Tellina quadrata, Gabb.—Pal. Cal., Vol. I., p. 159, pl. 23, fig. 138.

Middle Shales, Division D, north-west side of Hornby Island; J. Richardson, 1872. A well preserved and nearly perfect left valve.

Tellina (Peronæa) occidentalis, Meek. (Sp.)

Plate 17, figures 11 and 11*a*.

Thracia (?) *occidentalis*, Meek.—Trans. Alb. Inst., 1857, Vol. IV., p. 44.
—Bul, Geol. & Geogr. Surv. of Terr., Vol. II., No. 4, p. 363, pl. 2, figs. 3 and 3*a*.

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* See Meek's Report on the Cretaceous and Tertiary Fossils of the Upper Missouri Country, p. 195, pl. 2, figs. 11, *a*, *b*.
† American Journal of Conchology, Volume VI. (1870-71), p. 74.

Not *Tellina occidentalis*, Morton. —Jour. Ac. Nat. Sc. Phil., 1842, Vol. VIII., p. 210, pl. 11, fig. 3, which, according to Owen & Meek, is a *Lucina*.

? = *Tellina equilateralis*, Meek & Hayden.—1856. See Meek's Rep. on the Inv. Cret. and Tert. Foss. of the U. Miss. Co., p. 196, pl. 39, figs. 5*a*, *b*, *c*.

Compare also *Tellina Royana*, D'Orb. —Pal. Franc., Terr. Cret., Vol. III., p. 422 pl. 380, figs. 9-11.

Shell inequilateral, transversely subelliptical, about one-third longer than high, moderately convex, but a little compressed at the sides, test rather thin. Extremities narrowly rounded, the anterior side being the shortest and narrowest of the two; outline of base forming a broad, semi-elliptical curve. Dorsal margin sloping obliquely and somewhat rapidly in front of the beaks, and less so behind them; beaks small, not prominent or elevated, directed forwards and placed a little in advance of the middle. Postero-dorsal region compressed behind the posterior umbonal slopes.

Surface marked by irregular, concentric striations. Hinge teeth unknown. Pallial sinus elongated, oblique, ascending, with parallel or nearly parallel sides, and narrowly rounded at its inner termination below, but immediately under the beaks.

Length, fifteen lines and a half; height, ten lines.

Nanaimo, V. I., Meek (*Thracia occidentalis*). Lower Shales, Division B, at Gabriola Island (one example with both valves and most of the test preserved); also two miles and a half up the Nanaimo River, V. I., in Division A (four casts with portions of the shell remaining); J. Richardson, 1872.

The pallial line and muscular impressions are well defined in most of Mr. Richardson's specimens, and the shape of the sinus and direction of the beaks both show that the true position of this shell is in one of the subordinate groups into which the Linnæan genus *Tellina* has been divided, most likely, judging by its external characters only, in Poli's subgenus *Peronæa* as defined by recent systematists. As far as can be ascertained at present, the line of opening of the valves below is straight, and not curved posteriorly, and this appears to be the only difference between it and *Tellina equilateralis* of Meek & Hayden, the anal end of which is said to be "slightly flexed to the left." *T. occidentalis* of Meek, not Morton, is probably only a variety of *T. Royana*, D'Orbigny, in which the beaks are placed a little nearer than usual to the anterior end.

Linearia Suciensis. (N. Sp.)

Plate 17, figure 12.

Compare *Tellina strigata*, Goldfuss.—Petrefacta Germaniæ, Vol. II., p. 235, pl. 147, figs. 18*a*, *b*.

Shell compressed-convex, nearly equilateral, transversely subelliptical, length about one-third greater than the height, test rather thin. Anterior side narrowly rounded, posterior side a little longer than the anterior, subtruncated nearly vertically at the end, but most prominent above, and subangular at its junction with the ventral margin below; posterior area flattened obliquely, but without any distinct umbonal ridge; base nearly straight in the middle, but rounding upwards at each extremity. Beaks small, rather broad, but not prominent nor elevated, placed a little in advance of the middle and pointing distinctly forwards. Dorsal margin sloping very gently and somewhat convexly downwards in both directions, but slightly concave immediately under the beaks in front.

Surface marked by extremely fine, crowded, concentric striæ, and by radiating impressed lines. The latter are most strongly marked on the upper half of the shell, and become nearly obsolete before reaching the ventral margin. On the upper slopes of both extremities, especially on the posterior area, the radiating impressed lines are comparatively broad, so much so as to give to these declivities a finely ribbed aspect to the naked eye, but on the central area of the valves the impressed lines are very narrow and not visible without the use of a lens.

Hinge teeth and muscular impressions unknown.

Length, about eleven lines and a quarter; height, seven lines.

Sucia Islands, in Division A; J. Richardson, 1875. One right valve.

A very interesting little shell, whose external characters seem to be intermediate between those of *Palæomæra*, Stoliczka, and *Linearia*, Conrad. Its shape and surface ornamentation, both of which are very peculiar, are so like those of *Tellina strigata*, Goldfuss (the type of *Palæomæra*), that it may be only a variety of that species. The most appreciable difference between the two shells is that the beaks of *L. Suciensis* are placed very slightly in front of the middle, whereas those of *T. strigata* are situated a little behind the centre.

Tellina (*Linearia*) *sculptilis* of Stoliczka, from the Cretaceous rocks of Southern India, is also very nearly allied to the present species, and may perhaps be identical with it, but the beaks of the Indian shell are

described as prominent, and as being placed behind the middle, so that its posterior side is the shortest of the two. It is not easy to see why *T. strigata*, Goldfuss, and *T. sculptilis*, Stoliczka, are placed in different subgenera.

LINEARIA (LEIOTHYRIS) MEEKANA, WHITEAVES.

Tellina Meekiana, Whiteaves.—Geol. Surv. of Canada, Rep. of Progress 1873-74, p. 268, pl. of foss., fig. 6.

Shell compressed, very slightly convex, transversely but broadly ovate, the height (in the most perfect specimen known) being rather more than three-fourths of the length; test thin. Anterior side short and broadly rounded; posterior side much longer and narrower, bluntly pointed or very narrowly subtruncated at the end; outline of the basal half of the shell forming a regular semi-ovate curve. Beaks small, depressed, pointing forwards and placed about half way between the centre and the anterior end. Dorsal margin sloping convexly and very gradually downwards behind the beaks, straighter and descending much more rapidly and abruptly in front of them. Escutcheon or ligamental area very narrow, obliquely and slightly compressed, not bounded in each valve by a distinct umbonal ridge.

Surface marked by crowded, but rather irregular and not very minute, concentric striations. Hinge teeth unknown. Pallial sinus oblique, ascending, rather deep, extending nearly or quite to the middle of the valves and narrowly rounded at its inner termination.

Length, sixteen lines; height, thirteen.

Gabriola Island, in Division B; J. Richardson, 1871. The least perfect of the only two specimens yet obtained is narrower in proportion to its height than the one from which the above description was made.

The only fossil from the Cretaceous rocks of North America that might be mistaken for this species is the "*Tellina* (*Arcopagia?*) *Cheyennensis*" of Meek & Hayden,* from the forks of the Cheyenne River, Dakotah, but the last named shell may be readily distinguished by its more prominent beaks and by its larger and wider escutcheon.

* See Meek's Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country, p. 607, pl. 17, fig .16.

CYTHEREA (CALLISTA) LACINIATA, STOLICZKA.

Plate 17, figures 13 and 13*a*, and plate 19, figures 4 and 4*a*.

Cytherea (Callista) laciniata, Stoliczka. —Cret. Pelecyp. S. India, p. 174, pl. 7, figs. 5-6.

Compare *Cytherea (Callista) sculpturata*, Stol.—Id. p. 173, pl. 7, figs. 7-9.

Shell convex, inequilateral, very variable in shape; outline transversely and broadly ovate, ovately subtrigonal or subquadrangular but always a little longer than high. Beaks moderately large, slightly elevated in some specimens, but a little depressed in others, approximate, acute, curved inwards and forwards, and placed about half-way between the centre and the anterior margin. Superior border sloping concavely downwards in front and convexly behind; ventral margin forming a broad, semi-ovate curve, or gibbous near the anterior end and straighter or curving more gradually upwards near the posterior. Hinge area small, lanceolate, concavely and rather deeply excavated. Lunule small, narrow, ovate-cordate, and margined by a faintly impressed line.

Surface polished and concentrically ribbed; the ribs rounded, and wider than the deep furrows between them; not obsolete or nearly so on the umbones.

Pallial sinus deep, subangular, bluntly pointed, and extending to the middle of the shell. Left valve with three divergent teeth besides the sublunular tooth. The two cardinal teeth are short, and nearly transverse to the hinge line; the lateral tooth is elongated, nearly horizontal, and parallel with the fulcrum, from which it is separated by a narrow and not very deep groove. Right valve without any distinct sublunular tooth.

N. W. side of Hornby Island, in Division D, a fragment of a left valve; Sucia Islands, in Division A, abundant; J. Richardson, 1871, 1874 and 1875.

A small, neat and concentrically ribbed species, whose characters appear to be almost exactly the same as those of *C. laciniata*, described by Stoliczka, though the umbones of the latter shell are said to be nearly smooth, and its lunule is not described as margined by an impressed line. It may be that *C. laciniata* is only the young shell of *C. sculpturata*, Stoliczka. The Sucia Island specimens of the present species have the same shape and apparently the same kind of lunule as the *Meretrix arata* of Gabb, from the Chico group of California, but the surface of *M. arata* is said to be "ornamented by regular, concentric, acute impressed lines."

CYTHEREA (CARYATIS) PLANA, SOWERBY.

Plate 17, figures 14, 14*a*, and 14*b*.

Venus planus, Sowerby.	—Min. Conch., Vol. I., (1812) p. 58, pl. 20, lower figures.
Cytherea plana, Goldfuss.	—Petr. Germaniæ, Vol. II., p. 138, pl. 148, fig. 4.
Venus plana (Sowerby), D'Orbigny.	—Pal. Tranc., Terr. Cret., Vol. III., p. 447, Atlas, pl. 386, figs. 1-3.
Cytherea plana, Sowerby, Sp. Stoliczka.	—Cret. Pelecyp. S. India, p. 169, pl. 7, figs. 1-4
?=*Cytherea Leonensis*, Conrad.	—Emory's Rep. on the U.S. & Mex. Bound. Surv., 1857, Vol. I., p. 153, pl. 6, fig. 1.
?=*Meretrix Tippana*, Conrad.	—Jour. Ac. Nat. Sc. Phil., 1858, Series II., Vol. III., p. 326, pl. 34, fig. 18.
Aphrodina Tippana, Con.	—Am. Jour. Conch., 1868, Vol. IV., p. 246, pl. 18, fig. 5.
Compare also *Meretrix nitida*, Gabb.	—Pal. Cal., Vol. I., p. 165, pl. 23, figs. 145 and 146.
Caryatis nitida, Gabb.	—Id., Vol. II., p.p. 186 and 240, pl. 30, fig. 79.

Shell moderately convex, very inequilateral, variable in outline, but usually ovately subtriangular, length always a little greater than the height; test rather thick. Umbones broad and tumid in full grown shells, less so in small specimens; beaks very small, usually depressed but rarely a little elevated, curved inwards, downwards and somewhat forwards, placed at a distance from the anterior end of about one-third the entire length, or less, but never quite terminal. Anterior dorsal slope short, abrupt, and slightly excavated; posterior dorsal declivity longer, convex, and more gradual in its descent; outline of the basal margin forming a broad, semi-ovate curve, most prominent a little in advance of the middle; anterior end narrowly rounded; posterior end subtruncated. Lunule elongated, lanceolate or lanceolate cordate; bordered by an impressed line.

Surface polished, nearly smooth, marked by concentric striations, most of which are plainly visible to the naked eye, and on the upper and central parts only of the posterior end by very minute radiating lines which cannot be seen without the help of a lens. Pallial sinus deep, angular, pointed, and extending inwards nearly to the centre of the shell.

Right valve with three hinge teeth and a sublunular tooth. The two cardinal teeth are small, short, close together, and slightly divergent; they are placed immediately under the beaks, and are nearly transverse to the hinge line. The lateral tooth is elongated, oblique, and nearly

parallel with the hinge line behind; its summit, too, is concavely and sinuously grooved. The sublunular tooth, which is also elongated, commences at the margin of the valve opposite the base of the lunule; it ascends nearly parallel with the said margin, but separated from it by a deep groove, and terminates at a point opposite to the centre of the lunule.

The left valve has three hinge teeth, but no sublunular tooth. The two cardinal teeth diverge rather widely from above downwards, and the lateral tooth is parallel with the hinge line behind, from which it is separated only by a narrow and not very deep groove. The teeth of the left valve are not so well preserved as those of the right, and it is not yet known whether the anterior tooth in the left valve of the specimens collected by Mr. Richardson is larger than the middle one or not, though it certainly is as large, or whether the lateral tooth of the same valve is transversely rugose or smooth.

Middle Shales, Division D, north-west side of Hornby Island, four small single valves. Productive Coal Measures, Division A, at the entrance to Departure Bay, V. I., (one imperfect valve) and on the Nanaimo River, two miles and a quarter up (two examples), also at the Sucia Islands, where it is rather frequent; J. Richardson, 1871-75.

Although specimens from the above mentioned localities are variable in shape, as already mentioned, yet they do not appear to be nearly as much so as the Indian examples of *C. plana* figured by Stoliczka It would seem that the larger the shells the longer they are in proportion to their height, and *vice versa*. In some of Mr. Richardson's specimens the posterior end is so short and so broadly truncated as to give a subquadrate outline to the shell, but in others the anal side is produced and narrowly subtruncated or bluntly pointed at its termination. Again, out of twelve examples of *C. plana* from the Sucia Islands the apices of the beaks in eight are sunk decidedly below the highest level of the hinge line, and this appears to be always the case in adult shells, but in the four remaining, the largest of which is scarcely an inch long, the beaks are very slightly elevated.

Sowerby's description of *Venus plana* is too short to be very satisfactory, but his figures of the shell are excellent. Mr. Richardson's specimens are extremely like the types of the species, much more so than are the four Indian examples of *C. plana* represented by Stoliczka, and the characters of the former have been described rather minutely, to facilitate a comparison between them and two or three nominal species of *Veneridæ*

from the Cretaceous rocks of North America, which are probably nothing more than varieties of this well known European shell.

The first of these is the *Cytherea Leonensis* of Conrad, which Mr. Etheridge says is the commonest fossil at Nanaimo * Conrad's figure of *C. Leonensis* suggests the idea that the original may be an elongated variety of *Cytherea plana* with a rather strongly excavated lunular declivity, and an exceptionally long and narrow, but imperfect right valve of *C. plana* found by Mr. Richardson at Nanaimo rather favours this hypothesis.

Meretrix Tippana, Conrad, of which only a single left valve is known, and which is the type of Conrad's subgenus *Aphrodina*, is still more like the present species, not only in the general outline of the shell, but also in the shape of the pallial sinus and in the dentition of the hinge, as may be seen by any one who will take the trouble to compare Conrad's figure of the interior of *A. Tippana* in the fourth volume of the "American Journal of Conchology" with the corresponding figures of the same valve of *C. plana* in the first volume of the "Mineral Conchology," or in the third of the "Paleontologia Indica."

Caryatis nitida, Gabb, from the Chico Group of California, is probably also a local variety of *C. plana*. Mr. Gabb does not give a figure of an adult specimen of *C. nitida*, but his drawing of the young shell† corresponds to a not unusual form of *C. plana* when half grown, in which the beaks are elevated and the outline of the margin of the valves is somewhat rounded.

(CYTHEREA LEONENSIS, CONRAD.

Nanaimo, V. I. Etheridge. See the remarks which follow after the description of the preceding species.)

DOSINIA GYRATA, GABB.

Dosinia gyrata, Gabb.—Pal. Cal., Vol. I., p. 168, pl. 23, fig. 148.

Sucia Islands, in Division A; J. Richardson, 1875. A single right valve.

ERIPHYLA UMBONATA, GABB.

Eriphyla umbonata, Gabb.—Pal. Cal., Vol I., p. 180, pl. 24, figs. 162 and 162*a*.

Nanaimo River, V. I., two miles and a quarter up and at the Sucia Islands, in Division A; J. Richardson, 1872 and 1874. Five good speci-

* Quarterly Journal of the Geological Society of London, 1861, Vol. XVII., p. 432.
† In the second volume of the Palæontology of California, pl. 30, fig. 7, which should be compared with the specimen represented by Stoliczka in Vol. III. of the Indian Palæontology, pl. 7, fig. 8.

mens. The hinge teeth show that the species is a true *Eriphyla*, but the beaks are not quite as prominent in the shells from the Vancouver Cretaceous as they are in the types from California.

Cyprimeria lens, Gabb. (Sp.)

Plate 17, figures 15 and 15*a*.

Meretrix lens, Gabb.—Pal. Cal., Vol. I., p. 164, pl. 23, fig. 143.

North-west side of Hornby Island, in Division D; and Sucia Islands, in Division A. The few specimens collected by Mr. Richardson all belong to the broadly and transversely ovate, or subcircular form of the species. There is no distinctly margined or well defined lunule, and the three hinge teeth of the left valve are well shown. The first and second are slightly divergent, and the third, or posterior tooth, is parallel to the thick fulcrum, from which it is only separated in part by a shallow groove. The second and third teeth are thin and laminar, but the first, or anterior tooth, is thick, and excavated in the middle, but not bifid. It would appear also that there is a distinct sublunular tooth in the right valve.

(Cyprimeria ? tenuis, Meek.

Dosinia ? tenuis, Meek. —Proc. Ac. Nat. Sc. Phil., 1861., Vol. XIII., p. 315.
Cyprimeria ? tenuis, Meek.—Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, p. 361, pl. 2, figs. 5, 5*a* and 5*b*.

"At several places near Nanaimo, Vancouver Island, and on Newcastle Island; Cretaceous." Meek. Not in any of Mr. Richardson's collections.)

Genus Thetiopsis, Meek.

See Meek's "Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country," page 191.

Shell like that of *Thetis* (Sowerby), but with the pallial sinus comparatively short and not ascending higher than the centre of the shell. Pallial line crenated on either side of the sinus. Hinge teeth unknown. Type: *Venus* (?) *Circularis*, Meek & Hayden.

THETIOPSIS CIRCULARIS, MEEK & HAYDEN. (Sp.)

Venus (?) circularis, Meek & Hayden.—Proc. Ac. Nat. Sc. Phil., 1856, Vol. VIII., p. 272.
Cyclina (?) circularis, Meek. —Smithsonian Check-list N. Am. Cret. Fossils, 1864, p. 13.
Lucina Richardsonii, Whiteaves. —Geol. Surv. of Can., Rep. of Progr. for 1873-74, p. 266, plate of fossils, fig. 1.
Thetis (?) circularis, Meek. —Rep. on Inv., Cret. and Tert., Foss., of the U. Miss. Co., 1876, p. 190, pl. 17, figs. 8, *a*, *b*, *c*.

Hornby Island, north-west side, in Division D (one), Nanaimo River, V. I., ten miles up (one), and at the Sucia Islands, (two), in Division A; J. Richardson, 1871-75.

The type of *Lucina Richardsonii*, from ten miles up the Nanaimo River, is a nearly perfect specimen with the valves closed, and consequently with all the characters of the interior hidden from view. In proposing a provisional name for this shell the writer was much influenced by the statement previously made by Mr. Billings, on the authority of Messrs. Meek, Hayden & Gabb, that "the fossils of the Cretaceous formation on the east side of the Rocky Mountains are nearly all specifically distinct from those that occur in rocks of the same age on the west side,"* though the facts of the case, as we now know them, are far from corroborating this statement. One of the Sucia Island specimens of this species shows the pallial sinus very well, also the curiously crenated margin of the pallial line on either side of it, and all four accord exactly with Meek's figures and description of *Thetis circularis*, though Meek says that the beaks of *T. circularis* are curved obliquely forward and inward, whereas the beaks of Mr. Richardson's shells are divergent and curve outwards at their apices, much as in most species of *Dosinia*.

VENIELLA CRASSA. (N. Sp.)

Plate 18, figure 1.

Shell tumid, gibbous, but not as thick as high, very inequilateral; outline transversely ovate or ovately subtrigonal; length nearly a third greater than the height; test thick, except round the ventral margin, where it suddenly becomes thin and sharp. Anterior side very short, its margin slightly concave from the beaks to the middle, below which it rounds rapidly and abruptly into the curve of the ventral border; posterior side elongated, somewhat wedge shaped, but apparently obliquely

* Geological Survey of Canada. Report of Progress for 1872-73, p. 71.

truncated at its extremity; base semi-ovate. Beaks small, approximate, depressed, curved inwards and a little forwards, anterior, but not quite terminal. Behind the beaks the superior margin ascends, first in a broad and very slightly convex curve, after which it slopes gradually and gently downwards to the upper margin of the posterior end. Lunule not very distinctly defined, shortly and broadly lanceolate in outline, rather deeply excavated. In the rear of the beaks there are two areas, one of which is inside the other. The inner area, which appears to extend from the beaks to the posterior termination of the hinge line, is narrowly lanceolate, as seen from above, deeply excavated, and bounded on both sides by a sharp keel. The outer area is indicated only by an oblique flattening of the valves above, in the direction of a line which might be drawn from the beaks to the lower extremity of the posterior end, and its outline is broadly lanceolate. The hinge teeth are unknown, but the ligament was certainly external.

Surface marked by numerous concentric striæ, and, on the central and lower portion of the shell only, by four concentric grooves or arrests of growth, of which the first and second are well defined and wide apart, and the third and fourth more obscure and closer together.

Sucia Islands, in Division A; J. Richardson, 1874. A single specimen, with the test partly preserved on both valves, but imperfect at the anal end. In the figure the outline of the posterior termination of the shell has been restored from the lines of growth, and to some extent also from the shape and markings of the cast.

Lævicardium Suciense. (N. Sp.)

Plate 18, figure 2.

Shell convex, inequilateral, obliquely and ovately subtriangular, narrowest above and widest near the base; length and height nearly equal. Anterior side short and rather broadly rounded; posterior side somewhat longer, obliquely truncated at its extremity, and bluntly pointed at its junction with the ventral border; base broadly semi-ovate, rounded in front and flatter behind. Beaks large, prominent, approximate, incurved, directed also a little forwards, and placed in advance of the middle; umbones gibbous. No well defined lunule; posterior area narrow, flattened obliquely, and margined near the beaks by an obtuse, subangular keel or ridge, which becomes obsolete long before reaching the base behind.

Surface polished, shining, marked only by minute and crowded, but

not undulating, concentric striæ, which become coarser and much more rib-like on the posterior area. Hinge teeth and muscular impressions unknown.

Length, ten lines and a quarter; height, nine lines.

Sucia Islands, in Division A, two right valves; J. Richardson, 1875.

This shell may be a variety of *Lævicardium annulatum*, Gabb,* but it is more distinctly triangular, and its concentric striæ do dot appear to be undulating or marked by "small dots, composed of circular or elliptical impressed lines arranged in radiating series," as they are said to be in that species.

PROTOCARDIUM SCITULUM, MEEK. (Sp.)

Cardium scitulum, Meek.	—Trans. Albany Inst., 1857, Vol. IV., p. 40.
Protocardia scitula, Meek.	—Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, p. 360, pl. 3, figs. 4 and 4*a*.
?=*Leptocardia subquadrata*, Ev. & Sh. (Sp.)	—See Meek's Rep. on the Inv. Tert. and Cret. Fossils of the U. Miss. Co., p. 175, pl. 29, fig. 8, *a*, *b*, *c*, *d*, and *e*.
?=*Leptocardia rara*, Ev. & Sh. (Sp.)	—Idem, p. 176, pl. 17, figs. 1, *a*, *b* and *c*.

"Koomooks, Vancouver Island; Cretaceous." Meek. Blunden Point, V. I., two miles and a quarter and two miles and a half up the Nanaimo River, also at the Sucia Islands, in Division A; J. Richardson, 1871-75.

Mr. Meek has not failed to notice the strong resemblances that undoubtedly exist between the present species and the *Cardium subquadratum* and *C. rarum* of Evans & Shumard, from the Fort Pierre Group of Dakota. The only difference between Mr. Richardson's specimens of *P. scitulum* and the two Dakota shells that seems to be constant, is that the ribs on the posterior area of the former are distinct and strongly marked, while the corresponding costæ of the latter are either obscure, or nearly if not entirely obsolete. When the thin and polished outer layer of the test is exfoliated, which sometimes happens, the central area of the valves of *P. scitulum* appears to be concentrically ribbed, and specimens in this condition are very much like young individuals of the *C. altum* of Forbes.†

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* Palæontology of California, Vol. I., p. 171, pl. 23, fig. 152: and Vol. II., p. 187, pl. 30, fig. 81.
† Quarterly Journal of the Geological Society of London, Second Series, Vol. VII., 1846, p. 145, pl. 15, fig. 13.

Conchocele cretacea, Whiteaves.

Conchocele cretacea, Whiteaves.—Geol. Surv. Canada, Rep. Progr. 1873-74, p. 266, pl. of foss., figs. 2 and 2*a*.

Shell very inequilateral, convex, inflated, especially in the umbonal region; outline subquadrate, length nearly one fourth greater than the height; test thin. Umbones broad, tumid, anterior and terminal; beaks slender, subspiral, depressed, their apices curving downwards and a little outwards. Lunule large, ovate cordate, about one fourth higher than wide; concavely and shallowly excavated, its margin below being sharply angular, but not very prominent. Escutcheon or cardinal area very distinctly defined, broadly lanceolate as seen from above, and marked by two longitudinal and prominent keels or ridges on each valve. The two outer ones, which together form the outer boundary of the escutcheon, commence at the beaks, curve first outwards, then inwards, and finally meet at the upper termination of the posterior end. The two inner ridges both commence at the beaks, after which they each curve gently outwards, and then gradually inwards, until they meet on the cardinal border at a short distance from the posterior end. Their summits are acute, and they are each separated from the outer ridges and from the cardinal border, except at the point where they intersect the latter, by a deeply concave groove. Together they enclose a narrowly lanceolate and shorter subordinate area within the escutcheon.

Anterior margin shallowly concave under the beaks, and forming a subangular junction with the upward curve of the basal margin near or a little below the middle. Ventral border broadly rounded, curving upwards most rapidly at the posterior end, which is subtruncated and angular at its junction with the cardinal margin above. As viewed laterally, the outer ridge which bounds the escutcheon is so prominent as to hide most of the true cardinal margin from view, and in this aspect the outline of the former is slightly convex near the beaks, after which it slopes gently downwards to the upper termination of the shell posteriorly. A portion of the hinge margin, however, projects very slightly above the centre of the highest level of this ridge in the shape of a depressed but broadly convex lobe.

Surface marked by fine, subequal, concentric, raised striæ.

In the left valve the hinge appears to be composed of a single, long, sharp tooth, which runs parallel with the cardinal margin, and which extends from the beaks almost to the posterior end. In the right valve

there is a corresponding groove. Lunular margin of the valves very sharp, thin and toothless. Pallial margin simple, entire.

Length, eighteen lines; height, fourteen; thickness through the valves, twelve.

Below Dodd Narrows, V.I., in Division A; J. Richardson, 1872. Nine good specimens.

Lucina nasuta, Gabb.

Lucina nasuta, Gabb.—Pal. Cal., Vol. I, p. 175, pl. 24, fig. 159.

Sucia Islands, in Division A; J. Richardson, 1874. One small example.

A very imperfect specimen from below Dodd Narrows, V.I., which measures upwards of three inches in length and more than two in height, probably also belongs to this species.

Lucina subcircularis? Gabb.

Lucina subcircularis, Gabb.—Pal. Cal., Vol. 1, pp. 176, pl. 24, fig. 160.

Sucia Islands, in Division A; J. Richardson, 1874. A cast of the right valve, with fragments of the test preserved.

Clisocolus cordatus, Meek and Hayden. (Sp.)

Plate 18, Figures 3, 3a and 3b.

Cyprina cordata, Meek and Hayden.	—Proc. Ac. Nat. Sc. Phil., 1857, Vol. IX., p. 143.
Bucardia? Moreauensis, M. and H.	—Ib. 1860, Vol. XII., p. 426.
Glossus? Moreauensis, Gabb.	—1861, Cat. Cret. Fossils, p. 125.
Sphæriola? cordata, M. and H.	—Rep. on Inv. Cret. and Tert. Foss. U. Miss. Co., p. 137, pl. 29, figs. 3*a*, *b*, *c*.
? = *Sphæriola endotrachys*, Meek.	—Idem, p. 139, pl. 29, fig. 2.
Loripes dubia, Gabb.	—Pal. Cal., Vol. I., p. 177, pl. 24, figs. 170 and 171.
Clisocolus dubius, Gabb.	—Idem, Vol. II., p. 139, pl. 29, fig. 2.

Shell globose, very gibbous, especially in the umbonal region, higher than long, thickness through the valves about equal to the height. Sides and base rounded, the latter a little flattened; umbones broad, tumid, elevated and approximate; beaks placed a little in advance of the middle, subspiral, their apices divergent and curving outwards; no distinct lunule or posterior area.

Surface of young specimens concentrically ribbed and marked also by faint, radiating impressed lines. In adult shells the ribs almost disappear, their place being taken by coarse, irregularly disposed, concentric striations, and by a few broad, shallow and distant sulcations, the

results of former arrests of growth. At this stage of growth, too, the radiating lines become obsolete.

Pallial line entire, parallel with the base. Ligament external, lodged in a rather deep groove. Hinge teeth obsolete or nearly so. Hinge plate of the right valve swollen slightly and longitudinally under the beaks, the swelling being bounded posteriorly by a short, oblique excavation. Posterior end of the hinge plate of the left valve marked by a narrow, oblique groove, immediately under the fulcrum and parallel with it, evidently for the reception of the acute fulcral edge of the right valve.

Length of the largest specimen, twenty lines; height of the same, twenty-one lines. In another individual the length is eighteen lines, and the thickness through the valves is just equal to the length, the height being twenty lines.

Nanaimo River, V. I., two miles and a-quarter up, in Division A. A single cast. Sucia Islands, in the same Division, fourteen large and nearly perfect shells, most of them with both valves; J. Richardson, 1872 and 1875.

The specimens described above evidently belong to Mr. Gabb's genus *Clisocolus*, and are identical with the *C. dubius* of that author. Stoliczka thinks that *Clisocolus* may be synonymous with *Loripes* of Poli, but the former name may be conveniently retained for a group of fossil Lucinoid shells, some of which have been described as *Isocardiæ*, which are characterized not only by their edentulous hinge, but also by their globosely cordate shape and semispiral, divergent beaks. *Isocardia cretacea* of Goldfuss is probably a *Clisocolus*, and appears to differ from *C. dubius* only in its slightly more elongated form.

The description of "*Sphæriola* (?) *cordata*" (which Mr. Meek says "may possibly belong to an undescribed genus") applies so perfectly to the Sucia Island examples of the present species as to leave very little doubt in the writer's mind that *C. dubius* and *S. cordata* are different names for the same shell. *Sphæriola endotrachys* of Meek appears to be an elongated variety of *S. cordata*, the roughnesses on the cast of the former being probably due to a diseased condition of the mantle of the animal.

Opis Vancouverensis. (N. Sp.)

Plate 18, figures 4 and 4*a*.

Shell inequilateral, subpyriform or ovately subtrigonal, about twice as high as long, and widest near the base; test thick. Anterior side very

short, its margin broadly rounded below the middle, straighter above; posterior side short, obliquely truncated, and apparently angular or sub-angular at its junction with the ventral border below; basal margin regularly rounded in front, probably straighter behind. Umbones oblique, enormously developed; beaks situated in advance of the middle, acute, semispiral, and divergent at their apices. Behind the beaks a blunt but well defined keel or ridge extends to the base of the posterior end and separates a wide posterior area from the main body of the shell. This posterior umbonal keel is curved convexly above, but becomes much straighter below, and the posterior area, which is equal in height to the shell itself, is flattened at almost a right angle to the central portion of the valves. Lunule distinctly defined, ovate cordate in outline, not quite half the height of the shell, a little higher than broad, flatly excavated at nearly a right angle to the middle part of the valves.

Surface marked with concentric striæ of growth.

Hinge plate of the right valve (the only one known) very large, broadly triangular, and bearing in its centre a transversely elongated tooth, which is narrow and prominent above, but dilated and obliquely truncated below. On the anterior or lunular side this tooth is united to the hinge plate above, but on the posterior side it is separated from it by an oblique and probably ligamentary groove which runs parallel to the fulcrum. On either side of the tooth there is a deep, transversely elongated pit, evidently for the reception of two teeth in the left valve.

S. W. side of Denman Island, in Division B; J. Richardson, 1871. An imperfect right valve, with the surface much worn, and partly covered with the base of attachment of a living species of *Balanus*.

The lower half of the posterior margin of this specimen is badly broken, so that the exact outline of this part of the shell has yet to be ascertained. The lines of growth and the direction of the post-umbonal groove seem to indicate that the posterior margin formed a sub-angular junction with the ventral border, but it cannot be positively asserted that the base was not rounded behind. Although the characters of *O. Vancouverensis* are rather imperfectly known, yet they appear to be sufficiently intelligible to prevent it being confounded with any previously described species. In the general shape of the shell, and especially in the contour and proportionate size of the lunule and posterior area, there are many points of resemblance between it and *Opisoma Geinitziana* of Stoliczka,* but the present species is a true *Opis*, and has one tooth in the

* Cretaceous Pelecypoda of Southern India, p. 288, pl. 10, fig. 11.

right valve and two in the left, whereas in *O. Geinitziana* there are three teeth in each valve.

Astarte Conradiana, Gabb.

Plate 18, figures 5 and 5*a*.

Astarte Conradiana, Gabb.—Pal. Cal., Vol. I., p. 178, pl. 24, fig. 161.

Sucia Islands, in Division A.; J. Richardson, 1874 and 1875. Abundant, perfect and beautifully preserved.

The beaks of the Californian types of *A. Conradiana* are described as "overhanging the anterior end," but those of the specimens collected by Mr. Richardson are invariably placed at some distance from the front margin and are never quite terminal. Most of the hinge dentition is exhibited in two fragments, one of which is figured. There are two teeth in the left valve, one cardinal and the other lateral, and between the two there is a deep, oblique, triangular pit. The cardinal tooth is prominent, transverse and placed close to the lunular margin of the valve and parallel with it. The lateral tooth is elevated on the anterior half of the lower margin of the hinge plate only, and is grooved longitudinally above. In the opposite valve there is an oblique, triangular tooth immediately under the beak, but the posterior portion of the hinge of the only right valve in which the characters of the interior are exposed is too much broken to show whether there was a lateral tooth or not, or what it was like if there was.

Astarte Conradiana, var. Tuscana, Gabb.

Plate 18, figure 6.

Astarte Tuscana, Gabb. —Pal. Cal., Vol. I., p. 129, pl. 30, fig. 257.
Astarte cardinioides, Whiteaves. —Geol. Surv. Canada. Rep. Progr. 1873-74, p. 267, pl. of foss., fig. 3.
Astarte Vancouverensis, Whiteaves.—Idem, p. 267, pl. of foss., fig. 4.

North-west Bay, V. I., and at the Sucia Islands, in Division A; J Richardson, 1872 and 1874.

Mr. Richardson's specimens show clearly that *Astarte Tuscana* is only a variety of *A. Conradiana*. The posterior end of the present shell is doubtless narrower, more elongated, and more compressed laterally than it is in *A. Conradiana* proper, but in a large and fine series of both forms, from the Sucia Islands, the anterior end of each is precisely similar, as may be seen by a comparison of figures 5 and 6 on Plate 18. The types of *Astarte cardinioides* prove to be only large and badly preserved individuals of *A. Tuscana*, with their ribs worn flat under the matrix,

and *A. Vancouverensis*, also, has been found to be nothing more than an obliquely distorted specimen of *A. Tuscana.*

Trigonia Evansana, Meek.

Trigonia Evansana, Meek. —Trans. Alb. Inst., Vol. IV., p. 42.
Trigonia Evansii Gabb, as of Meek.—Pal. Cal., Vol. I., p. 189, pl. 25, fig. 177.
Trigonia Evansii, Meek. —Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4 p. 359, pl. 2, figs. 7, 7*a* and 7*b*.

"Cretaceous beds at Nanaimo, Vancouver's Island." Meek. North-west Bay, V.I., seven or eight specimens with the shell preserved, also at the Sucia Islands, a few casts, with portions of the exfoliated test attached; both in Division A; J. Richardson, 1872 and 1874.

Trigonia Tryoniana, Gabb.

Plate 18, figure 7.

Trigonia Tryoniana, Gabb.—Pal. Cal., Vol. I., p. 188, pl. 25, fig. 176.

North-west Bay, V.I., in Division A; J. Richardson, 1872. The only specimen yet obtained, which is represented in the figure, is a tolerably perfect and well preserved left valve of a local variety of *T. Tryoniana*, in which the oblique series of tubercles are unusually numerous and closely disposed.

Nucula pectinata (?) Sowerby.

Plate 18, figure 8.

Nucula pectinata, Sowerby. —Min. Conch., Vol. II., p. 207, pl. 192, figs. 6 and 7.
Nucula pectinata, Mantell. —Geol. of Sussex, pl. 19, figs. 5 and 9.
Nucula pectinata, D'Orbigny.—Pal. Franc., Terr. Cret. Vol. III., p. 178, Atlas, pl. 303, figs. 8-14.

Lower part of the Trent River, in Division B; J. Richardson, 1871. A distorted left valve, whose surface has been pressed down on, and its margin strongly indented by, a large fragment of *Entalis Cooperi* which lies obliquely under it. The crowded radiating ribs of this specimen are in every respect similar to those of *N. pectinata*, and due allowance being made for the distortion of the former, the shape of the two shells is also very nearly alike, though the beaks of the Trent River shell are placed a little farther from the posterior end than they appear to be in Sowerby's species. In Woodward's "Manual of the Mollusca," page 269, it is stated that the umbones of shells of the genus *Nucula* are "turned towards the short posterior side," and hence it would seem that the excavated space which D'Orbigny calls the lunule of *N. pectinata*, is really the posterior area or escutcheon.

Nucula (Acila) truncata, Gabb.

Nucula truncata, Gabb. —Pal. Cal., Vol. I., p. 198, pl. 26, fig. 184.
Nucula (Acila) truncata, Gabb.—Idem, Vol. II., pp. 197 and 250.

North-west side of Hornby Island, in Division D; Gabriola Island and S.W. side of Denman Island, in Division B; Nanaimo River, V. I., two miles and a quarter up, and Protection Island, in Division A; J. Richardson, 1871-75.

(Nucula Traskana, Meek.

Nucula Traskana, Meek.—Trans. Alb. Inst., 1857, Vol. V., p. 39.
Nucula Traskana, Meek.—Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, p. 356.

Nanaimo or Comox, V.I. Meek. "A species which," Mr. Meek says, "will probably be recognized by its ventricose, trigonal-ovate form, and nearly central beaks." No shell corresponding to the descriptions of *N. Traskana* has been detected in any of Mr. Richardson's collections.)

Yoldia Striatula, Forbes. (Sp.)

Plate 18, Figure 9.

Leda striatula, Forbes. —Trans. Geol. Soc. Lond, Series 2, Vol. VII., p. 148, pl. 17 fig. 14.
Yoldia striatula, Stoliczka.—Cret. Pelecyp. S. India, p. 323, pl. 4, fig. 2, and pl. 17, fig. 6.

North-west side of Hornby Island, in Division D.; South-west side of Denman Island, in Division B.; Sucia Islands, in Division A.; J. Richardson, 1871-75.

Besides the concentric striæ of growth, the surface of the valves of this little shell is marked with minute, sub-oblique, impressed lines, which are not visible to the naked eye. These latter were carefully described and figured by Forbes, but Stoliczka did not seem to be aware of their existence, or at any rate makes no mention of them.

Axinæa Veatchii, Gabb.

Axinæa Veatchii, Gabb. Pal. Cal., Vol. I., p. 197, pl. 25, figs. 183 and 183a.

North-west side of Hornby Island, in Division D.; Blunden Point (large and common), North-West Bay (also numerous and large), and entrance to Departure Bay, V. I.; also at the Sucia Islands (where it is plentiful but usually small), in Division A.; J. Richardson, 1871–75.

(ARCA ? EQUILATERALIS, MEEK.

Arca (Cucullæa ?) equilateralis, Meek.—Trans. Alb. Inst., 1857, Vol. IV., p. 40.
Arca ? equilateralis, Meek. —Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, p. 357, pl. 2, figs. 6 and 6*a*.

"Nanaimo (?) Vancouver Island; Cretaceous." Meek. Not obtained at any of the localities visited by Mr. Richardson.)

NEMODON VANCOUVERENSIS, MEEK. (Sp.)

Plate 19, figures 1 and 1*a*.

Arca Vancouverensis, Meek. —Trans. Alb. Inst, Vol. IV., p. 40.
Arca Breweriana, Gabb. —Pal. Cal., Vol. I., p. 193, pl. 25, fig. 181.
Grammatodon ? Vancouverensis, Meek.—Bul. Geol. and Geogr. Surv. Terr., Vol. II., No. 4, p. 356, pl. 3, figs. 5 and 5*a*.

"Koomooks, Vancouver Island; Cretaceous." Meek. South-west side of Hornby Island, in Division D; south-east end and south-west side of Denman Island, in Divisions C and B; Sable River and Blunden Point, V. I., in Division A; J. Richardson, 1871-73.

This species was described from individuals which were probably immature; for the length of the type figured by Meek is stated to be 0·75 inch, and the height 0·47. The specimens collected by Mr. Richardson, which are believed to be referable to *A. Vancouverensis*, show that the shell, when adult, attained to a length of upwards of three inches, and to a height of about twenty-two lines. The dentition of the hinge is always remarkably constant in its characters, but the outline of the valves varies considerably in different individuals. In some the hinge line and basal margin are nearly parallel, the posterior end is rather squarely truncated, and the two extremities are nearly equal in breadth. This must be regarded as the typical form, it being the one which corresponds most nearly to Meek's description and figures of *A. Vancouverensis*. In another variety the posterior side is distinctly wider than the anterior; the hinge line and basal margin are not quite parallel, but somewhat divergent, and the cardinal margin ascends gradually from the anterior to the posterior end; the ventral border rounds up rapidly in a broadly convex curve from the middle of the valves to the termination of the hinge line in front; the posterior end is obliquely truncated above and bluntly pointed below. The fine adult specimen from Blunden Point, represented on plate 19, gives a good idea of the shape of this variety, which, however, is connected with the more typical form of the species by several intermediate gradations.

The hinge plate, which is nearly as long as the shell itself, is straight above, slightly arcuate below, and widens outwards at each end. Opposite to the beaks, or a little behind them, there are a few minute, crowded, granular denticles, arranged obscurely in three obliquely ascending, but nearly transverse, rows. The whole of the teeth proper are large, elongated, horizontal and nearly parallel with the cardinal margin, but at their inner terminations they curve distinctly downwards. In the adult shell there are three or four anterior and five posterior teeth in the right valve, while in the left there are three anterior and four posterior. The anterior teeth of both valves are grooved transversely, but the posterior teeth are smooth. The nearer the teeth are to the inner margin of the hinge plate the shorter they are, and *vice versa*. The upper posterior tooth is more than half the length of the hinge line.

Mr. Meek says: "I am not well enough acquainted with the hinge of this little shell to be quite sure that it is congeneric with the form on which I proposed to found the genus *Grammatodon* in the "Palæontology of the Upper Missouri." One of the casts shows a little of the impression of the hinge in front of the beaks, with apparently four or five small teeth or denticles, ranging obliquely forward and upward." *

The hinge dentition of the sub-genus *Nemodon* is thus described by Conrad: "Hinge line long and straight, or slightly curved under the umbo; hinge in the left valve with three linear teeth parallel with the anterior cardinal margin; posterior lateral tooth double, very long, linear; under the apex a few granular teeth." † The number of posterior lateral teeth is obviously not of generic importance, depending as it does on the age or size of the shell. In *Arca Eufalensis*, the type of *Nemodon*, which is represented as about an inch in length, there appear to be two posterior teeth in the left valve. In a right valve of *A. Vancouverensis* not quite an inch and a-half long there are two long, linear furrows and one short one at the posterior end of the hinge plate, evidently for the reception of two fully developed teeth, and one rudimentary tooth in the opposite valve. There can be little doubt, therefore, that the present species should be referred to *Nemodon* rather than to *Grammatodon*.

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* Bulletin of the Geological and Geographical Survey of the Territories, Vol. 2, No. 4, p. 857

† American Journal of Conchology, Vol. V., (1870) p. 97.

CUCULLÆA (IDONEARCA) TRUNCATA, GABB.

Plate 19, figures 2 and 2*a*.

Cucullæa truncata, Gabb. —Pal. Cal., Vol. I., p. 196, pl. 25, fig. 182.

?= *C. (Idonearca) Nebrascensis*, Owen.—See Meek's Rep. Cret. and Tert. Foss. U. Miss. Co., p. 88, pl. 29, figs. 5, *a*, *b*.

?= *C. (Idonearca) Shumardi*, M. & H.—See the same work, p. 86, pl. 28, figs. 15*a–g*, and pl. 29, fig. 4.

Possibly a var. of *C. glabra*, Parkinson.—For the synonymy of this species see Pictet & Campiche's Pal. Suisse, Foss. Ste. Croix, Vol. III., p. 456.

Middle Shales, Division D, of the west side of Hornby Island; Lower Shales, Division B, of Gabriola Island; Productive Coal Measures, Division A, at Nanaimo River, two miles and a-half up, and North West Bay, V. I.; also at the Sucia Islands; J. Richardson, 1871-75.

This species is subject to considerable variation, both in shape and sculpture. In some specimens the margin of the posterior end is truncated almost vertically and the posterior side is shorter than the anterior. Others have almost exactly the same outline as the "mature specimen" of *Cucullæa Nebrascensis* figured by Meek, and in these the posterior side is longer than the anterior, the former being produced and very obliquely truncated at its termination. Young shells, about an inch in length, are marked by crowded radiating ribs, which are nodulous in consequence of their being crossed by equally numerous, raised, concentric striæ. In adult individuals the radiating ribs are never nodulous, and sometimes become nearly obsolete. The left valve is invariably larger than the right. The height, as measured from the top of the beaks to the base, is usually a little less than the length, and slightly greater than the thickness through the closed valves. The test of aged shells is upwards of four lines in thickness. On the inside of the test there is a prominent, sharp ridge, which bounds the inner side of the posterior muscular impression. The hinge plate is broad at the ends and narrow in the middle; it bears three or four elongated teeth at each end, and a few rather small, transverse teeth or denticles in the centre. The lateral teeth, which are striated or grooved across, are parallel with the cardinal margin, and their inner ends are apparently not bent downwards. The central teeth or denticles are each as wide as that part of the hinge plate on which it is placed, and are not minute, granular, or arranged in two or three rows which ascend obliquely upwards and outwards, as in *Nemodon*. Some of these central denticles are little more than raised, rounded tubercles.

According to Mr. Gabb, "*C. truncata* is allied to *C. Nebrascensis*, Owen; but differs in the smaller beaks, proportionally longer form, more oblique truncation posteriorly, and in being more produced in the anterior basal region." "There is also," he adds, "a difference in the hinge. In *C. Nebrascensis* the lateral teeth radiate, as it were, from an imaginary point, while in the present species they are parallel with each other and with the upper edge of the hinge plate, and their inner ends are bent at a right angle." * Since these remarks were written Mr. Meek has published excellent new descriptions and figures of *C. Nebrascensis*, and a comparison of these with twenty more or less perfect specimens of *C. truncata* from the Vancouver Cretaceous shows that the beaks of *C. truncata* are fully as large as those of *C. Nebrascensis*, and that the hinge dentition and outline of the valves are alike in both.

There are several reasons for supposing that *Cucullæa Nebrascensis* of Owen, *C. Shumardi* of Meek & Hayden, and *C. truncata* of Gabb, have been separated as distinct species on insufficient grounds, and that all three may be mere varieties of the *C. glabra* of Parkinson, of which *C. fibrosa*, Sowerby, is generally admitted to be a synonym. At present it does not seem possible to distinguish detached immature valves of *C. truncata* from those of *C. Shumardi* or *C. fibrosa* by any known character, and *C. Nebrascensis* appears to bear the same relation to *C. Shumardi* and to *C. truncata* that *C. glabra* does to *C. fibrosa*. In *C. glabra* proper, as the name imports, and in *C. Nebrascensis*, the radiating ribs are absent or nearly so at all stages of growth, but in *C. fibrosa*, *C. Nebrascensis* and *C. truncata* they are always present, though sometimes rather obscure.

In 1860 Mr. Meek united *C. Shumardi* to *C. fibrosa*, but subsequently changed his opinion on this point, on the ground, first, that *C. fibrosa* "is a Gault and Greensand species," while *C. Shumardi* "has only been found in beds equivalent to the true chalk;" † and, secondly, because D'Orbigny states that the right valve of *C. fibrosa* is the largest of the two, whereas in *C. Shumardi* the left valve is the largest. But to these arguments it may be replied: (1) that the circumstance that *C. fibrosa* is known to occur in the Lower Greensand, Gault, and Upper Greensand of Europe, is no reason why it should not be found on the horizon of the chalk proper in America; and (2), though D'Orbigny certainly does say that the right valve of *C. fibrosa* is larger than the left, yet on figure 6 of

* Palæontology of California, Vol. I., p. 196.
† Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country, p. 87.

plate 312 of the Atlas to Volume III. of the "Terrains Crétacés," which is described as a cast of *C. fibrosa*, viewed at the buccal side, the left valve is unquestionably represented as the largest.

It is, however, only proper to add that in an adult specimen of *C. glabra* figured by D'Orbigny the length is one-third greater than the height, whereas in *C. truncata* and *C. Nebrascensis* the height and length are often nearly equal, and in the most elongated specimens of the latter yet collected, the length is only one-sixth greater than the height.

Mytilus pauperculus, Gabb.

Mytilus pauperculus, Gabb. —Pal. Cal., Vol. I, p. 183, pl. 25, fig. 165.
Compare *M. subarcuatus*, Meek & Hayden. —See Meek's Rep. on Inv. Cret. & Tert. Foss. U. Miss. Co., p. 69, pl. 38, figs. 2*a*, *b*.

Sucia Islands, in Division A; J. Richardson, 1874. A single right valve, rather more than half-an-inch long. The specimen is higher and not quite so much elongated as the California shell figured by Gabb, but probably belongs to the same species.

Modiola ornata, Gabb.

Modiola ornata, Gabb.—Pal. Cal., Vol. I., p. 184, pl. 24, fig. 166.

N. W. Side of Hornby Island, in Division D, and at the Sucia Islands, in Division A; J. Richardson, 1871-74. A small and imperfect valve from each locality. Closely allied to *Modiola pedernalis*, Rœmer, from the Cretaceous rocks of Texas, but the two species may be easily distinguished by the position of the beaks, which are terminal in *M. pedernalis* and subterminal in *M. ornata*. Both belong to Swainson's sub-genus *Brachydontes*.

Pinna calamitoides, Shumard.

Plate 20, figures 1, 1*a* and 1*b*.

Pinna calamitoides, Shumard.—Trans. Ac. Sc. St Louis, 1858, Vol. I., p. 124.

"Shell elongated, triangular, compressed, slightly curved, umbones rounded; buccal portion attenuated; ligament margin acute, arcuate; pallial margin gently concave; surface marked with about fourteen slender, rounded, longitudinal ribs, separated by much wider spaces than the ribs. On the ligamental side of the shell these ribs are quite distinct, regular and nearly equidistant, but on the pallial portion they are partially effaced and assume the form of irregular and rather broad folds."

"Dimensions.—Apicial angle, 28°; at the distance of about two inches from the point of the beak the width is 13 lines, and the thickness 6 lines."

"A single specimen only of this shell has come under my observation. It is somewhat mutilated, the extremities being broken off and the surface more or less exfoliated. An examination of more perfect individuals may therefore render it necessary to slightly modify the above description."

"For. and Loc.—Cretaceous formation of Nanaimo River, Vancouver Island. The fragment of rock in which the specimen was embedded is a dark, greenish, argillaceous, sandy-textured limestone, with dark, igneous pebbles disseminated through it." Shumard.

Six well-preserved fragments of this species were collected by Mr. Richardson in 1874, at the Sucia Islands, in Division A, but they give very little additional information as to its characters. The cardinal margin and the shell itself both seem to be straight and not arcuate or curved, and the outline of a portion very near to the anterior termination of the valves, indicates that the beaks were probably narrow and acute rather than rounded. *Pinna Breweriana* of Gabb, from the Chico Group of California, is very closely allied to the present shell, and may prove to be identical with it.

(MELEAGRINA ANTIQUA, GABB.

Meleagrina antiqua, Gabb.—Pal. Cal., Vol. II., p. 192, pl. 31, fig. 89.

"From Departure Bay, Nanaimo, Vancouver Island, associated with *Trigonia Evansana*, *Pecten Traskii*, and other fossils equally characteristic of the Chico Group." Gabb. No specimens of this shell were collected by Mr. Richardson.)

INOCERAMUS UNDULATO-PLICATUS, RŒMER.

Plate 20, figures 2 and 2*a*.

Inoceramus undulato-plicatus, Rœmer.—Die Kreidebildungen von Texas (1852) p. 59, pl. 7, fig. I.

"Testa oblique ovata, subtetragona, parum convexa, concentrice irregulariter striata, radiatim undulato-plicata; plicis latis, parum elevatis, subnodosis, a linea testæ diagonali ad peripheriam divergentibus, subarcuatis. Strato superiore fibroso testæ tenui." At the waterfall of the Guadalupe below New-Braunfels, Texas. Rœmer.

"Septarian clays at Nanaimo and Valdez Inlet:" Etheridge. Lower Shales, Division B, at Sable River, V. I., not very common; Productive Coal Measures, Division A, at Blunden Point and North West Bay, V. I., abundant, perfect, and in fine condition; J. Richardson, 1871 and 1872.

A peculiarly sculptured shell, not likely to be mistaken for any

described European species. On a cursory examination the markings of its valves remind one, in a general way, of those of *Plicatula*, or of some species of *Alectryonia*. The folds diverge downwards and outwards to the lateral margins on either side, the points of divergence being coincident with an oblique line which might be drawn from the posterior side of the beaks to the centre of the opposite extremity. In some specimens the folds, whose summits are invariably rounded, are prominent and distant; in others they are not so much elevated, and closer together. The largest individual collected by Mr. Richardson is fully five inches and a half in height, from the summit of the beaks to the opposite margin.

Inoceramus mytilopsis, Conrad.

Plate 20, figure 3.

Inoceramus mytiloides, Rœmer.—Die Kreidebildungen von Texas, p. 60, pl. 7, fig. 5 (As of Mantell.)

Inoceramus mytilopsis, Conrad.—Emory's Rep. U. S. and Mex. Bound. Surv., Vol I., p. 152, pl. 5, figs. 6*a*, *b*.

Texas: Rœmer and Conrad. Septarian clays at Nanaimo and Valdez Inlet; Etheridge. Trent River, V. I., above and below the falls, also Bradley Creek, in Division B; J. Richardson, 1871.

As will be seen by the synonymy above quoted, Dr. Ferdinand Rœmer has identified this shell with the *Inoceramus mytiloides* of Mantell, which most palæontologists have united to the widely distributed *I. problematicus* of Schlotheim, while Conrad regards it as a distinct species. The Trent River specimens of *I. mytilopsis* are in all respects similar to the Texan shell figured by Rœmer, and both differ from the typical form of *I. mytiloides* or *I. problematicus* in their proportionately longer hinge line, which runs much more nearly parallel with the longest axis of the valves, also in their more closely arranged and more regular concentric folds, which might justly be described as ribs. The anterior border of most individuals is truncated inwardly and obliquely beneath the beaks, and the posterior portion of the pallial border is nearly straight, so that the margin of the lower half of the shell is subangular in the middle; the posterior extremity also is subtruncated. These latter characters, however, are not constant, for in one or two of the Vancouver examples of *I. mytilopsis* the margin of the lower half of the shell is not subangular in the middle, but forms a broadly rounded semiovate curve which extends from the beaks to the termination of the posterior end below, and the hinder extremity is narrowly rounded.

In the comparative length of its hinge line, this *Inoceramus* somewhat resembles the Nebraska variety of *I. problematicus* described and figured by Meek as *I. problematicus, var. aviculoides.**

Inoceramus Vancouverensis, Shumard.

Plate 20, figures 4, 4*a* and 4*b*.

Inoceramus Vancouverensis, Shumard.	—Trans. Ac. Sc. St. Louis, Vol. I., (1858) p. 123.
?= *Inoceramus Elliotii*, Gabb.	—Pal. Cal. Vol. II., (1869) p. 193, pl. 31, fig. 90*a*.
?= *Inoceramus altus*, Meek.	—Hayden's Rep. Geol. Surv. Terr., 1871, p. 302.
" " " "	—Rep. Inv. Cret. and Tert. Foss. U. Miss. Co. p. 43, pl. 14, figs. 1*a*, *b*.
Compare *Inoceramus propinquus*, Munster.	—Goldfuss. Petr. Germ. Vol. II, (1840) p. 112, pl. 109, figs. 9*a*, *b*.

"Shell large, ovate subquadrate, not very oblique, gibbous and sloping gradually but somewhat irregularly to the basal margin, height equal to or greater than the length; cardinal margin straight or very slightly arched; buccal and basal margins regularly rounded, and forming together nearly a semicircle; anal side lengthened, its margin gently arched, and forming, with the cardinal margin, rather more than a right angle; umbo very ventricose above; beaks directed obliquely forward, incurved, very elevated, obtusely pointed, situated nearest the buccal margin; surface marked with broad, rounded, unequal concentric folds, and fine, nearly equidistant, slightly prominent concentric lines. In very young specimens a few longitudinal striæ are to be seen passing over the umbo, which, in most specimens in the collection, becomes suddenly very ventricose, and forms a circumscribed, ovate tumor. In other specimens, however, although there is a swelling of this part of the shell, it does not rise so abruptly from the general surface. This latter variety of our shell resembles somewhat *Inoceramus convexus* (Hall & Meek), from which it is easily distinguished by the concentric lines of the surface, which are much wider apart. The *I. Vancouverensis* is also much less oblique, and this character also separates it from *I. Sagensis* (Owen), to which it bears some resemblance."

"Dimensions.—The measurements of the best specimen in the collection are—length, four inches; height, four inches; thickness of left valve,

* Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country, p. 68, pl. 9, fig. 4.

three-quarters of an inch. There are, however, some fragments which show that this species attains a much greater size, perhaps more than double the dimensions here given."

"Form. and Loc.—Occurs in the dark argillaceous, compact limestone of Nanaimo River, Vancouver's Island."–Shumard.

Nanaimo River, two miles and a quarter up, Protection and Saturna Islands; Vesuvius Bay on Salt Spring or Admiralty Island; in Division A; a few, not very good specimens from each of these localities. Sucia Islands, also in Division A, ninety-five examples, many of which are well preserved and nearly perfect; J. Richardson, 1871-75.

In about ninety or ninety-five per cent. of the specimens of *I. Vancouverensis* collected by Mr. Richardson, the height of the shell is manifestly greater than its length. The margin of the buccal side of this prevalent form of the species, though broadly rounded in some individuals, is straight or truncated almost vertically in others, and these latter shells can scarcely be distinguished from the *I. altus* of Meek. *I. Elliotii* of Gabb appears also to be possibly synonymous with *I. Vancouverensis*. It is quite likely that the present species may prove to be identical with the *I. propinquus* of Munster, which Eichwald, Geinitz, Pictet and Stoliczka regard as a large variety of *I. problematicus*, Schlotheim. Goldfuss' description and figures of *I. propinquus* apply remarkably well to most specimens of *I. Vancouverensis*, though, as a general rule, the concentric plications of the latter shell are generally more prominent, distant and regular than they are represented as being in *I. propinquus*.

A few exceptional specimens of *I. Vancouverensis* broaden rapidly below the middle, so that the maximum length of the shell equals, or even exceeds the height. It was probably this form of species that Dr. Shumard had in view when he compared it with *I. convexus* and *I. Sagensis*. *I. convexus*, however, has a long hinge line, which is nearly parallel with the longer diameter of the valves and belongs, therefore, to the sub-genus *Catillus:* Zittel and Pictet both think it may be a variety of *I. Crippsi*. *I. Vancouverensis*, on the other hand, always has a short hinge line, and is a typical *Inoceramus*, in the sense in which that genus has recently been restricted and redefined by Meek.

Some specimens of the broad, short variety of *I. Vancouverensis* approach rather near to *I. Nebrascensis;* var. *Sagensis*, so far as the general outline of the valves is concerned, but Mr. Meek says that the beaks of the latter shell do not rise much above the hinge margin, and are scarcely incurved, whereas those of *I. Vancouverensis* are both prominent

and very decidedly curved inwards. The extraordinary protuberance of the umbones in some individuals of this species, to which reference is made by Dr. Shumard, appears to the writer to be due to a distortion of the shell at an early stage of growth.

INOCERAMUS NEBRASCENSIS, VAR SAGENSIS.

Inoceramus Nebrascensis, Owen. —Rep. Geol. Minnesota, Iowa and Wisconsin, (1852) p. 582, pl. 8, fig. 1.

Inoceramus Sagensis, Owen. —Ib., pl. 7, fig. 3.

Inoceramus Sagensis, var *Nebrascensis, Meek.*—Rep. Inv. Tert. and Cret. Foss. U. Miss. Co., p. 52, pl. 13, figs. 2*a*, *b*.

"Septarian clays at Nanaimo and Valdez Inlet;" Etheridge. Sucia Islands, in Division A; J. Richardson, 1874. A single right valve, measuring about four inches and a quarter in length, by three inches and three quarters in height.

(INOCERAMUS TEXANUS, CONRAD.

Inoceramus Texanus, Conrad.—Emory's Rep. on the U. S. and Mex. Bound. Surv., Vol, I., (1857) p. 152, pl. 5, fig. 7.

"Septarian clays at Nanaimo and Valdez Inlet;" Etheridge. An imperfectly characterized species, not identified as occurring in any of Mr. Richardson's collections.")

INOCERAMUS CRIPPSII, VAR PROXIMUS.

Inoceramus proximus, Tuomey. —Proc. Ac. Nat. Sc. Phil., 1854, Vol. VII. p. 171.

Inoceramus subundatus, Meek. —Id., 1861, Vol. XIII., p. 315.

I. proximus, Tuomey? Meek. —Rep. Inv. Tert. and Cret. Foss. U. Miss. Co., (1876) p. 53, pl. 12, figs. 7*a*, *b*.

" " " " *var subcircularis*, Meek.—Ib. p. 55, pl. 12, figs. 2*a*, *b*.

I. Crippsii, var subundatus, Meek. —Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, (1876) p. 358, pl. 3, figs. 1 and 1*a*, but perhaps not figs. 3 nor 3*a* of the same plate.

?=*I. Whitneyi*, Gabb. —Pal. Cal., Vol. II., (1869) p. 193, pl. 32, fig. 91.

Lower part of the Trent River, in Division B; Nanaimo River, two miles and a quarter up, and Blunden Point, V.I., also at the Sucia Islands, in Division A; J. Richardson, 1871-74.

The writer feels satisfied that the *I. proximus* from Mississippi, Alabama and the Upper Missouri Country cannot be satisfactorily separated from the *I. subundatus* of Vancouver Island, even as a tolerably well marked

variety. *I. Whitneyi* of Gabb, from the Chico Group of California, appears to be more like the type of *I. Crippsii* as figured by European writers, and differs from the present shell only in its somewhat greater length in proportion to its height, and in its slightly more prominent beaks.

Inoceramus Crippsii, var. Suciensis.

Inoceramus Crippsii, var subundatus, Meek. (in part.)—Bul. Geol. and Geogr. Surv. of Terr., Vol. II., No. 4, pl. 3, figs. 3, 3*a*, but not figs. 1 and 1*a* of the same plate.

Shell tranversely subovate, not much longer than high; anterior side wider as well as much shorter than the posterior; posterior side somewhat produced, narrowing rapidly upwards from below, and obliquely subtruncate at the end; ventral border gibbous a little in advance of the middle; umbones prominent, beaks acute.

"Sucia Islands; Cretaceous." Meek. S. W. side of Denman Island, in Division B; J. Richardson, 1871. A detached right valve, with portions of both layers of the test preserved.

This and the preceding shell both appear to be short and broad forms of *I. Crippsii*, but in the variety *proximus*, (or *subelongatus*) the posterior side is wider than the anterior, and the umbones are not prominent. Mr. Meek's figures on plate 3 of Vol. II., No. 4, of the Bulletin of the Geological and Geographical Survey of the Territories give a very correct idea of the outline of the valves, and of the relative proportions of the umbones in both varieties; but it is worthy of note that the right valve of the *var. Suciensis*, from Denman Island, is much more inflated than it is represented as being in the specimen figured by Mr. Meek, and that the concentric folds of the former are nearly obsolete.

Inoceramus Crippsii, var. Barabini.

Inoceramus Barabini, Morton. —Syn. Org. Rem., (1834) p. 62, pl. 17, fig. 3.
Inoceramus gibbus, Tuomey. —Proc. Ac. Nat. Sc. Phil., (1854) Vol. VII., p. 170.
Inoceramus cuneatus, Meek & Hayden. —1860, Ib., p. 181.
Inoceramus Crippsii? var. *Barabini*, Morton.—Meek. Rep. Inv. Tert. and Cret. Foss. U. Miss. Co., p. 49, pl. 12, fig. 3, pl. 13, figs. 1*a*, *b* and *c*, also woodcuts Nos. 1 and 2 on p. 50.

New Jersey, Morton; Alabama, Tuomey; Yellowstone River, Mon-

tana; Meek. Sucia Islands, in Division A; J. Richardson, 1874. Six good specimens.

This is the oblique, transversely elongated, and narrowly subovate form of the species, which is regarded by Meek as the type of Morton's *I. Barabini.*

(INOCERAMUS CONFERTIM-ANNULATUS, RŒMER.

Inoceramus confertim-annulatus, Rœmer.—Die Kreidebildungen von Texas (1852), p. 59, pl. 7, fig. 4.

" " " Conrad, in Emory's Rep. on the U. S. and Mex. Bound. Surv., Vol. I., (1857) p. 151, pl. 5, fig. 5.

"Nanaimo and Valdez Inlet." Etheridge. Apparently a compressed variety of *I. Crippsii*, with close set, numerous, concentric undulations. No specimens were collected by Mr. Richardson which accord precisely with the descriptions and figures of Rœmer's species.)

LIMA MULTIRADIATA? GABB.

Lima multiradiata, Gabb.—Pal. Cal., Vol. II., p. 201, pl. 33, fig. 101.

Entrance to Departure Bay, in Division A; J. Richardson, 1871.

An imperfect cast of both valves of a rather large *Lima* of the *Plagiostoma* group, which may possibly be referable to the species mentioned above, but which is not in a condition to be determined with much certainty. On the cast of the left valve between thirty-five and forty acute, somewhat sinuated, radiating ribs may be counted, which are separated by rather wider and shallowly concave interspaces, but on fragments of the rather thick test which still adhere to the cast of the right valve the ribs are nearly obsolete, though the lines of growth are well marked.

(PECTEN TRASKII, GABB.

Pecten Traskii, Gabb.—Pal. Cal., Vol. I., p. 200, pl. 26, fig. 187, and Vol. II., p. 198, pl. 32, fig. 95.

"North shore of Departure Bay, near Nanaimo, Vancouver Island." Gabb. A fragment of a valve of a *Pecten* collected at the same locality by J. Richardson in 1871 may belong to this species, but only the inner surface of the test is visible, the exterior being completely buried in the [illegible], tenacious matrix.)

HINNITES, OR SPONDYLUS. (Sp. undt.)

Entrance to Departure Bay, V. I., in Division A; J. Richardson, 1871. Two very imperfect single valves.

EXOGYRA. (Sp. undt.)

Entrance to Departure Bay, V. I., in Division A; J. Richardson, 1871. An upper valve, rather more than an inch and a-half in height and a little less than an inch in length, but imperfect round the margin, and with the test exfoliated.

Its shape is essentially the same as that of the corresponding valve of the *E. parasitica* of Gabb* and the *E. interrupta* of Conrad,† both of which are possibly varietal forms of the *E. haliotoidea* of Sowerby and other European writers. These three shells have one character in common, namely, that the keel or ridge on the upper valve, which extends in a gradually uncoiling spiral from the beaks to the base, is marginal or very nearly so; whereas in the specimen now under consideration the central and lower portions of the keel are separated from the outer edge of the valve by a rather wide space.

OSTRÆA. (Sp. undt.)

Entrance to Departure Bay, V. I., in Division A; J. Richardson, 1871. Fragments only of a very large, massive species, whose test is eleven lines, or nearly an inch in thickness in the middle. The outer surface of the shell is either exfoliated or else buried under the rock.

ANOMIA VANCOUVERENSIS, GABB.

Plate 20, figures 5, 5*a*, 5*b*, 5*c* and 5*d*.

Anomia Vancouverensis, Gabb.—Pal Cal., Vol. II., p. 202, pl. 33, fig. 102.
Compare *Anomia lineata*, Gabb.—Ib., Vol. I., p. 203, pl. 26, fig. 193.

Two species of *Anomia* are described and figured in the "Palæontology of California." The first of these is the *Anomia lineata*, of which only the upper valve is known, and which is stated to be common at several localities in California, in the Chico Group. Its principal characters are summarized by Mr. Gabb as follows: "Shell thin, variable in shape; commonest form subcircular, often obliquely truncated on the right side;

* Palæontology of California, vol. I., p. 205, pl. 26, figs. 192a, b, and pl. 31, fig. 273a.

† Journal of the Academy of Natural Sciences of Philadelphia, Vol. 3, Second Series, p. 330, pl. 34, fig. 15.

beak of upper valve small, distinct, marginal or submarginal. Surface marked by fine, linear, radiating ribs, often dichotomous, sometimes laterally undulated and crossed by concentric lines of growth, which sometimes become squamose. Muscular scar large. Under valve unknown." The second is the *A. Vancouverensis*, from "Departure Bay, near Nanaimo," of which only the lower valve has been obtained, which is thus described by Mr. Gabb: "Shell circular, thin; upper valve unknown; lower valve flat, marked by strong lines of growth and by very faint radiating lines; aperture elongated, oblique, occupying nearly a third of the diameter of the shell. Diameter one inch." Mr. Gabb also remarks: "It is not impossible that this may prove to be the under valve of *A. lineata*, nob., which belongs to the same group in the same formation, and of which the lower valve is unknown."

Pieces of the blackish or dark bluish-grey shales of Division B, collected by Mr. Richardson in 1871 on the banks of the Trent River, V. I., above the falls, are full of detached upper valves of a species of *Anomia*, which the writer has very little hesitation in referring to *A. Vancouverensis*. Upwards of sixty or seventy more or less perfect specimens have been obtained, and many were unavoidably broken in splitting up the pieces of shale in which they were imbedded, but not a vestige could be discovered of the lower or perforated valve, although it was carefully searched for. The upper valve is convex or compressed-convex: its outline is very variable, the most common form being transversely ovate; the right side being produced and narrowly rounded at the end, while the left side is short and broadly rounded at the margin. Some specimens are more elongated transversely than others, but the length is always greater than the height. The beaks, which are small, marginal, and not much elevated, are situated at varying distances between the centre and the left margin, but are sometimes placed very near the latter. The concentric striæ of the surface are well marked, even on the cast, and where the test is preserved, which is not often the case, it is covered externally with exceedingly minute and flexuous or bent, radiating striæ, which are too small to be seen with the naked eye, and which can only be defined clearly by the use of a somewhat powerful simple lens. Besides their own proper sculpture, these upper valves are often impressed with the fine or coarse ribbing, as the case may be, of other shells to which they were formerly attached, the most abundant species with which they are associated being *Ptychoceras Vancouverense* and *Inoceramus mytilopsis*.

If the specimens last described are really the upper valves of *A.*

Vancouverensis, it would seem that the only difference between that species and *A. lineata* is, that in the latter shell the radiating markings are somewhat coarser than they are in the former; for in Mr. Gabb's figure of *A. lineata* the "fine, linear, radiating ribs" are represented as plainly visible to the naked eye.

BRACHIOPODA.

Terebratula Wacoensis, Roemer.

Terebratula Wacoensis, Roemer.—Die Kreidebildungen Von Texas, p. 81, pl. 6, figs. 2, *a*, *b*, *c*.

Banks of the Trent River, V.I., in Division B; J. Richardson, 1871. A well preserved and nearly perfect cast.

Rhynchonella. (Sp. undt.)

Sucia Islands, in Division A; J. Richardson, 1874. One nearly perfect but immature specimen, which is little more than a cast, and two or three detached valves in an equally bad state of preservation.

A rather coarsely ribbed species, with a shallow and indistinctly defined mesial fold and sinus. The height and length of the shell appear to be very nearly equal. The beak of the ventral valve is large and prominent, and the number of ribs in the largest specimen collected is about twenty.

Discina Vancouverensis. (N. Sp.)

Plate 20, figure 6.

Upper valve, the only one known, large, depressed-conical, its margin nearly circular in outline, but narrowing very slightly behind; apex not very prominent nor much raised, placed a little on the posterior side of the middle, but very nearly central. Surface marked apparently with regularly-disposed, nearly equi-distant, concentric striations, or raised lines of growth.

Greatest diameter, about an inch and a quarter.

S. W. Side of Ganges Harbour, on Salt Spring or Admiralty Island, in Division A; J. Richardson, 1874. An imperfect upper valve with the surface water-worn, and consequently with the finer surface markings obliterated.

ANTHOZOA.

SMILOTROCHUS (?) VANCOUVERENSIS. (N. Sp.)

Plate 20, figures 7 and 7*a*.

Corallum small, shortly and broadly conical, not much higher than wide, slightly curved, transverse section nearly circular in outline, upper margin oblique, sides spreading and rapidly divergent, base acute. Calyx apparently rather shallow, septa about thirty, extending from the outer wall to within a short distance of the centre. Surface marked with crowded, smooth (?) radiating ribs.

Greatest height, five lines; breadth at the top, four lines.

S. W. side of Hornby Island, in Division D; J. Richardson, 1871. A single, imperfect and badly preserved specimen.

The surface markings are not well shewn, and the upper margin of the coral is partly broken away. The ribs and septa both appear to have been smooth, and neither seem to have been elevated above, or to have projected beyond, the upper margin of the coral. The septa are so crushed and distorted that it is impossible to make out their cyclical arrangement, but they appear to have been grouped originally in pairs, which coalesce or unite at their inner terminations, and which alternate with simple, entire septa.

Platytrochus speciosus, of Gabb and Horn,* is straighter than the present species, its upper margin is more nearly horizontal, and its septa and costæ are said to be both granulous and exsert.

Smilotrochus curtus,† of the Chico Group of California, has "the base rounded or very blunt," and the "sides but slightly diverging."

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* "Journal of the Academy of Natural Sciences of Philadelphia," New Series, Vol. IV., p. 399. pl. 69, figs. 15-17.

† "Palæontology of California," Vol. II., p. 205, pl. 34, figs. 106 and 106*a*.

CONCLUSION.

With the exception of a few fragmentary remains of plants, the whole of the fossils collected by Mr. Richardson are from the lower part of the formation, or, to speak more accurately, from Divisions A to D (inclusive) of the Comox area, and from Divisions A and B of the Nanaimo Coal-field and its outlier in the Cowitchen district. The following table has been constructed to show the range of each species or well-marked variety in these lower and subordinate divisions of this part of the Vancouver Cretaceous, and in the four larger groups into which the entire series of the Cretaceous rocks of California has been divided by Mr. Gabb. The list in the centre contains the names of ninety-four species, seventeen of which are new to science, and five named varieties: six species out of the hundred mentioned on page 94 being represented by specimens which are too imperfect to be identified with a reasonable degree of probability.

Vancouver Cretaceous.				Names of Species in Mr. Richardson's Collections.	California Cretaceous.			
A.	B.	C.	D.		Shasta Group.	Chico Group.	Martinez Group.	Tejon Group.
				CEPHALOPODA.				
•				Nautilus Suciensis				
•			•	" Campbelli				
•	•		•	Heteroceras Conradi				
•	•			Ammonites Gardeni				
•				" Vancouverensis				
•				" Velledæ	?			
•				" Selwynianus				
	•		•	" Indra				
•	•			" complexus, var. Suciensis		•		
•	•		•	" Newberryanus				
9	5		4	(*Carried forward*)		1		

Vancouver Cretaceous.				Names of Species in Mr. Richardson's Collections.	California Cretaceous.			
A.	B.	C.	D.		Shasta Group.	Chico Group.	Martines Group.	Tejon Group.
9	5		4	.....(*Brought forward*).....		1		
		•		Ammonites Jukesii				
•				Hamites cylindraceus.....				
	•			Ptychoceras Vancouverense.....				
•	•			Baculites Chicoensis ?.....		?	?	
•			•	" occidentalis.....				
				GASTEROPODA.				
•				Surcula Suciensis				
•			•	" raricostata				•
•	•		•	Fulgraria Navarroensis.....		•		
•				Fusus Kingii.....		•		
			•	Serrifusus Dakotensis, var. Vancouverensis				
•			•	Perissolax brevirostris.....		•	•	
	•			Littorina compacta.....		•		
•	•		•	Potamides tenuis.....		•		
•			•	" " var. Nanaimoensis....				
•	•			Cerithium Lallierianum, var. Suciense.				
	•			Tessarolax distorta.....		•		
•				Anchura stenoptera.....				
•				" exilis			•	
•				Amauropsis Suciensis.....				
•	•		•	Gyrodes excavata.....		?		
•	•			Sycodes glaber.....		•		
•				Hindsia nodulosa.....				
26	14	1	12	.....(*Carried forward*).....		8	2	1

Vancouver Cretaceous.				Names of Species in Mr. Richardson's Collections.	California Cretaceous.			
A.	B.	C.	D.		Shasta Group.	Chico Group.	Martinez Group.	Tejon Group.
26	14	1	12	.....(*Brought forward*).....		8	2	1
•				Cirsotrema tenuisculptum.....				
•				Opalia Mathewsonii				•
•			•	Margarita ornatissima.....		•		
•				Stomatia Suciensis.....				
•				" " var. carinifera.....				
	•			Anisomyon Meekii?.....	?			
•	•		•	Cinulia obliqua.....		•		
•				Cinuliopsis typica.....				
•	•		•	Haminea Hornii.....				•
•	•		•	Dentalium Nanaimoense.....		?		
				(?=D. stramineum, Gabb.)				
•	•		•	Entalis Cooperi.....		•	•	•
				LAMELLIBRANCHIATA.				
•	•			Teredo Suciensis.....				
•				Martesia clausa.....		•	•	•
			•	Corbula Traskii?.....		?		
			•	" minima				
•				Periploma suborbiculatum.....				
•				Anatina sulcatina.....				
	•			" Tryoniana. (Loose, J. R.).....		•		
•				Thracia subtruncata.....				
•	•			Pholadomya Royana.....		•		
•				Homomya concentrica.....		•		
•	•		•	Cymbophora Ashburnerii		•	•	•
44	23	1	20	.....(*Carried forward*).....		16	5	6

Vancouver Cretaceous.				Names of Species in Mr. Richardson's Collections.	California Cretaceous.			
A.	B.	C.	D.		Shasta Group.	Chico Group.	Martines Group.	Tejon Group.
44	23	1	20	.....(*Brought forward*)		16	5	6]
•	•		•	Mactra Warrenana		?		
				(?=Smooth var. of C. Ashburnerii.)				
•				Tellina Mathewsonii		•		
			•	" quadrata.....		•		
•	•			" occidentalis (Meek not Morton.).				
•				Linearia Suciensis.....				
	•			Linearia (Leiothyris) Meekana.....				
•			•	Callista laciniata.....				
•			•	Caryatis plana.....		•		
•				Dosinia gyrata.....				•
•				Eriphyla umbonata		•		
•			•	Cyprimeria lens.....		•		
•			•	Thetiopsis circularis.....				
•				Veniella crassa				
•			•	Lævicardium Suciense.....				
•				Protocardium scitulum.....				
•				Conchocele cretacea.....				
•				Lucina nasuta.....			•	
•				" subcircularis.....		•		
•				Clisocolus cordatus.....		•		
	•			Opis Vancouverensis.....				
•				Astarte Conradiana.....		•		
•			•	" " var. Tuscana.....		•		
•				Trigonia Evansana.....		•		
64	27	1	28	.....(*Carried forward*).....		26	6	7

Vancouver Cretaceous.				Names of Species in Mr. Richardson's Collections.	California Cretaceous.			
A.	B.	C.	D.		Shasta Group.	Chico Group.	Martinez Group.	Tejon Group.
64	27	1	28	.....(*Brought forward*).....		26	6	7
•				Trigonia Tryoniana.....		•		
	•			Nucula pectinata?.....				
•	•		•	" truncata		•	•	•
•	•		•	Yoldia striatula.....				
•	•		•	Axinæa Veatchii.....		•	•	
•	•	•	•	Nemodon Vancouverensis.....		•		
•	•		•	Cucullæa truncata.....		•		
•	•		•	Mytilus pauperculus.....			•	
•			•	Modiola ornata.....				•
•				Pinna calamitoides		?		
				(?=P. Brewerii, Gabb)				
•	•			Inoceramus undulato-plicatus.....				
	•			" mytilopsis.....				
•				" Vancouverensis		?		
				(?=I. Elliotii, Gabb.)				
•				" Nebrascensis, var. Sagensis.				
•	•			" Crippsii, var. proximus.....		?		
				(?=I.Whitneyi, Gabb.)				
•	•			" Crippsii, var. Suciensis.....				
•				" " var. Barabini.....				
•				Lima multiradiata?.....		?		
	•			Anomia Vancouverensis.....		?		
				(?=A. lineata, Gabb.)				
80	39	2	35	.....(*Carried forward*).....		31	9	9

Vancouver Cretaceous.				Names of Species in Mr. Richardson's Collections.	California Cretaceous.			
A.	B.	C.	D.		Shasta Group.	Chico Group.	Martines Group.	Tejon Group.
80	39	2	35	.....(*Brought forward*).....		31	9	9
				BRACHIOPODA.				
	*			Terebratula Wacoensis.....				
*				Discina Vancouverensis.....				
				ANTHOZOA.				
			*	Smilotrochus Vancouverensis.....				
81	40	2	36	.....(*Total*).....		31	9	9

An analysis of the columns on the left hand side of this table shows that forty-two species or varietal forms, or considerably more than one-third of the whole, are common to two or more of Mr. Richardson's divisions.

It has already been remarked that by far the largest number of species are from the Productive Coal Measures, or Division A. These deposits, which seem to be peculiarly favourable to the preservation of the shells of mollusca, &c., occupy a much greater superficial area than all the rest of the formation, and have been examined with special care in consequence of their economic importance. In the Cowitchen area, however, they have so far only yielded a few good specimens of *Heteroceras Conradi*, an undetermined species of *Inoceramus*, and some fossil plants.

The Lower Shales (Division B) appear at the surface only on or near the shores of Baynes' Sound on Vancouver and Denman Islands in the Comox district, and on Gabriola Island in the Nanaimo area.

The Lower Conglomerates (Division C) have been observed only at one locality on the east side of Denman Island and on Norris Rock. The extreme paucity of fossils in these conglomerates seems to be partly due to the limited extent of the exposures of the latter, and partly, also, to the fact that this part of the series is largely made up of fragments of the underlying and mostly crystalline, non-fossiliferous rocks.

All the fossils yet collected from the Middle Shales (Division D) are from the west side of Hornby Island, though the supposed equivalents

of these shales have been recognized also on Gabriola, Valdez and Galiano Islands.

No remains of any characteristic vertebrata or invertebrata have yet been found in the three upper Divisions. E, F and G, of the Comox Coal Field, or in Divisions C to G, inclusive, of the Nanaimo district.* Yet, as the whole of these Divisions, from A to G, inclusive, lie conformably the one on the other, in regular succession, it is at least highly probable that they all belong to the same formation.

Turning next to the columns on the right hand side of the table it will be seen that at least one species of Cephalopoda, ten of Gasteropoda and nineteen of Lamellibranchiata, collected by Mr. Richardson, occur also in the Chico Group of California, and that about nine per cent. of the fossils in the list are common to the Coal-bearing rocks of Vancouver and to the Martinez and Tejon Groups.

In the second volume of the Palæontology of California, Prof. Whitney and Mr. Gabb maintain that the coal-bearing formation of Vancouver Island is of the same age as the Chico Group, and this is no doubt true as regards Divisions A and B of the Comox and Nanaimo districts, which were the only parts of the formation that had been examined at that time. Mr. Richardson's collections show that the Productive Coal Measures of the Cowitchen area and Divisions C and D of the Comox Coal field also form part of the same north-westerly continuation and modification of the Chico Group.

The Martinez is now generally regarded as only a local sub-division of the Chico Group, of which it forms the uppermost member. It will be noticed that seven out of nine Martinez species collected by Mr. Richardson in the Vancouver Cretaceous occur also in the Chico Group.

Mr. Conrad has claimed that the Tejon Group is of Eocene age, but in the Nanaimo and Comox districts nine well known Tejon species occur in rocks which hold unquestionable Cretaceous fossils, such as *Ammonites* and *Baculites*.

In California, the Chico Group, (with the Martinez,) probably represents the Lower and Upper Chalk of Europe, while, according to Mr. Gabb, the Tejon Group corresponds very nearly to the Maestricht beds. On palæontological and stratigraphical grounds, it also seems most likely that the coal formation of the Nanaimo, Cowitchin and Comox districts is

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* Some obscure organisms from the Upper Conglomerates (G.) of Hornby Island on the north side of Tribune Bay, which Mr. Richardson thought were fragments of a guard of a Belemnite (G. S. C., Rep. Prog., 1872-73, p. 51), appear to the writer to be pieces of the shelly tube of a *Terebella*, possibly of *T. Gustavsis*.

the equivalent in time of the whole of the Upper as distinguished from the Middle Cretaceous, or, in other words, of all those deposits which intervene between the Gault and the Eocene. The four lower divisions of these coal-fields are almost certainly Upper Cretaceous, but at present there is no positive evidence to show whether the three upper Divisions are Cretaceous or Tertiary. In California the Martinez Group has never been seen resting directly upon the Chico, nor the Tejon upon the Martinez, but in the Vancouver Upper Cretaceous the stratigraphical sequence of the different Divisions is complete throughout. The local names given by the California geologists to the principal groups of the Upper Cretaceous rocks as developed in that State, lose all their significance when applied to the corresponding deposits on Vancouver and the adjacent islands in the Georgian Strait.

In an appendix to one of Mr. Richardson's reports, Mr. Billings remarks: "According to the researches of Mr. F. B. Meek and Dr. F. V. Hayden in Nebraska, and of Mr. W. M. Gabb in California, the fossils of the Cretaceous formation on the east side of the Rocky Mountains are nearly all specifically distinct from those that occur in rocks of the same age on the west side." "This would seem to establish the existence of a land barrier between the two regions at an early period, and upon this land most probably grew the plants whose remains occur so abundantly in the rocks in question."* In Mr. Meek's monograph of the Cretaceous fossils of the Upper Missouri Country, published in 1876, the only species described as possibly common to the Cretaceous rocks of that region and to those of California and Vancouver Island, is *Ammonites complexus*. The last edition of Prof. Dana's Manual of Geology, dated 1874, contains a map of North America as it appeared in the Cretaceous period, in which the limits of this supposed land barrier are distinctly defined, (except to the north-westwards,) its general direction being represented as nearly coincident with that of the main axis of the Rocky Mountains.

The same facts, however, are capable of an entirely different interpretation, as may be seen by the following quotation from the second volume of the Palæontology of California. "The occurrence of the Cretaceous fauna on the western face of the Sierra Madre," Mr. Gabb says, in a passage which seems to have escaped the notice of Mr. Billings and Prof. Dana, "is a matter of great interest, since it proves conclusively that during that era there must have been a water communication

* Geological Survey of Canada. Report of Progress for 1872-73, p. 71.

between the great Cretaceous sea that covered so much of what is now the central portion of our continent on the one side and the Pacific on the other."..."It is the more remarkable when taken into connection with the fact, that of the more than three hundred species now known in the California Cretaceous, barely one per cent. is found in common on the two sides of the continent."..."From the occurrence in California of *Gryphæa vesicularis* and *Turritella seriatim-granulata*, determined with certainty, and of *Nautilus Texanus* and *Volutilithes Navarroensis*, yet open to doubt, it seems that there was not a continuous land barrier between the two basins."....."It is very probable that future explorations in the yet unknown region between the Saskatchewan and the Pacific, north of our boundaries, will develop a more or less continuous series of Cretaceous deposits showing a similar link on the north."..."The presence of *Ammonites complexus* on Vancouver Island and in California, and the known existence of Cretaceous beds in Eastern Oregon and northwest of the great lakes, render this hypothesis not improbable." *

The results of the most recent explorations in the Vancouver Cretaceous are decidedly in favour of the conclusions arrived at by Mr. Gabb, and the hypothesis of a continuous land barrier between the oceans of the period is scarcely tenable in the present state of our knowledge of the subject. Mr. Richardson's collections, so far as they go, show that the faunæ of the Upper Cretaceous of Vancouver and Texas are even more closely related than are those of the same period in California and Texas, and the missing link between the two Cretaceous oceans to the north-westwards is also, to a certain extent, supplied by these Vancouver fossils. Inclusive of those described in the present report, the exact number of named species of marine invertebrata now known from the Vancouver Upper Cretaceous is one hundred and eight, and eighteen of these are believed to occur also in rocks of the same age on the eastern side of the Rocky Mountains, as shown more in detail in the subjoined lists.

1. Species common to the Upper Cretaceous of Vancouver and Texas.

(A. In Mr. Richardson's collections.)

Fulguraria Navarroensis.	Inoceramus mytilopsis.
Anatina sulcatina.	Terebratula Wacoensis.
Inoceramus undulato-plicatus.	

* Palæontology of California, Vol. II., pp. 257, 258.

(B. In Mr. Etheridge's lists of Nanaimo, Comox, and Valdes Inlet fossils, omitting *Trigonia crenulata*, which Mr. Meek says is his *T. Evansana*.)

Ammonites Texanus.	Inoceramus Texanus.
Cytherea Leonensis.	Inoceramus confertim-annulatus.

2. Fossils found in the Upper Cretaceous of Vancouver, Mississippi, and Alabama.

Gyrodes excavata. (=G. Spillmanii.)	Inoceramus Crippsii, var. proximus
Caryatis plana. (=Aphrodina Tippana.	" " var. Barabini.

3. Species which occur in the Upper Cretaceous of Vancouver and New Jersey.

Heteroceras Conradi.	Inoceramus Crippsii, var. Barabini
Gyrodes excavata. (=Natica infracarinata.)	

4. Fossils believed to be common to the Upper Cretaceous of Vancouver and to the Fort Pierre and Fox Hills Groups of Dakota, Nebraska and Montana.

Serrifusus Dakotensis.	Inoceramus Sagensis, var Nebrascensis.
Mactra Warrenana.	" Crippsii, var. proximus.
Thetiopsis circularis.	" " var. Barabini.
Clisocolus cordatus.	

5. Species from the Upper Cretaceous of Vancouver and the Upper Missouri Country which have been separated on very slight differences, and, in some cases, perhaps, on insufficient grounds.

Vancouver Cretaceous.	*Cretaceous of the U. Missouri Country.*
Ammonites complexus, var. Suciensis, Meek.	Ammonites complexus, Hall & Meek.
Dentalium Nanaimoense, Meek.	Dentalium gracile, Hall & Meek.
Tellina occidentalis, Meek (Sp.) Not Morton.	Tellina equilateralis, Meek & Hayden.
Protocardium scitulum, Meek.	Protocardium subquadratum and rarum of Evans and Shumard.
Cucullæa truncata, Gabb.	Cucullæa Nebrascensis, Owen.
Mytilus pauperculus, Gabb.	Mytilus subarcuatus, Meek & Hayden.
Inoceramus Vancouverensis, Shumard.	Inoceramus altus, Meek.

The theory that the two oceans of the Cretaceous period in North America were isolated by a continuous land barrier is open also to objections of a purely physical character. Dr. F. V. Hayden and other geologists whose opportunities for a practical study of the question have

been exceptionally favourable, maintain that the latest elevation of the Rocky Mountains took place at a period long subsequent to the deposition of the Cretaceous rocks. The exact words made use of by Dr. Hayden in reference to this subject are:—"We believe, therefore, that the elevated ridges which form the nuclei of the mountain ranges began to emerge above the surface of the surrounding country, near the close of the Eocene period." "We think, also, that the evidence is clear that there were periods of subsidence and repose, but the thought which we wish to illustrate is, that there was a slow, long-continued, quiet, upward tendency which began near the close of the Cretaceous epoch, and culminated in the present configuration of the western portion of our continent, near the commencement of our present period."* Along the eastern flanks of the Rocky Mountains, on the "Third Prairie Plateau," in the vicinity of the forty-ninth parallel, strata holding marine fossils of Cretaceous age are known to occur at an elevation of at least 3,000 feet above the present sea level. Even if we suppose that the latest elevation of the Rocky Mountains had been effected prior to the accumulation of those marine sediments, and that the whole continent was subsequently submerged to the depth of 3,000 feet, a water communication between the two oceans would still be possible to the north-westwards, by the valley of the Peace River, as suggested to the writer by Dr. G. M. Dawson.

In the Cretaceous rocks of Europe and Southern India, whose local faunæ have been studied and described by so many palæontologists, it is found that a large number of the species have a very wide geographical distribution. Stoliczka, for instance, says that one fourth of the Cretaceous Cephalopoda, and twelve per cent. of the Pelecypoda (or lamellibranchiata) of Southern India, occur also in deposits of the same age in Europe. Some of the fossils of the Vancouver Cretaceous appear to have an equally extensive geographical range, as may be seen by the following list of species, most of which are believed to be common to the coal-bearing rocks of the Nanaimo and Comox districts and to the chalk formation of Europe, Asia or Africa.

6. Vancouver Upper Cretaceous species which occur in other localities than North America.

Ammonites Gardeni, Bailey. —Cape of Good Hope; Bailey. S. India and (?) Austria; Stoliczka.

" Velledæ, Mich. —Gault of France and Switzerland; Pictet. Caucasus and S. India; Stoliczka.

* American Journal of Science and Arts, Second Series, Vol. 33, (1862), p. 313.

Ammonites Indra, Forbes.	—S. India; Forbes and Stoliczka.
" Jukesii? Sharpe.	—Chalk of Londonderry, Ireland; Sharpe.
Hamites cylindraceus? Defr.	—U. Chalk, France; Maestricht beds, Denmark: Pictet.
Cerithium Lallierianum, D'Orb.	—Gault of France and Switzerland; Pictet.
Gyrodes excavata, Mich.	— " " " " "
Corbula minima, D'Orb.	—Trichinopoly district of S. India; D'Orbigny and Stoliczka.
Pholadomya Royana, D'Orb.	—Senonien or Upper Chalk of the Pyrenean basin; D'Orbigny.
Caryatis plana, Sby. (Sp.)	—Upper Greensand of England, Germany and France, Pictet. S. India; Stoliczka.
Nucula pectinata? Sby.	—Gault of England and France. The Hornby Island shell is perhaps distinct from the true *N. pectinata*.
Yoldia striatula, Forbes.	—S. India; Forbes and Stoliczka.
Inoceramus Crippsii, Mant.	—Almost world wide.

Fulguraria Navarroensis of Shumard, which is found in the Upper Cretaceous of Texas, California, Vancouver and the Sucia Islands, is probably only a variety of the *F. elongata*, D'Orbigny, of France and S. India; and *Cucullœa truncata*, Gabb, from Vancouver and California, is barely distinguishable from the European *C. glabra*.

PLATE XI.

NAUTILUS SUCIENSIS (page 97.)

Figure 1. Side view of the most perfect specimen yet collected.

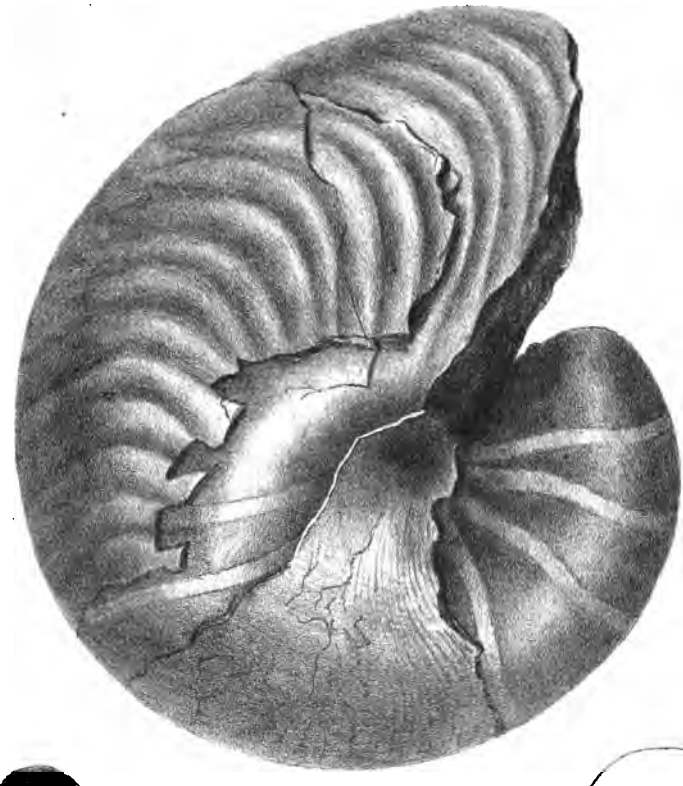
" 1 *a*. Outline of a septum of the same, to show the position of the siphuncle.

NAUTILUS CAMPBELLI, Meek (page 99.)

Figure 2. Outline of a detached septum of a small specimen.

" 2 *a*. Another portion of the same specimen, with some of the loose outer chambers removed, showing the cancellate sculpture of the early whorls, and the projecting, shelly cones surrounding the deep, narrow, umbilical perforation.

" 2 *b*. Sculpture of a part of ditto, highly magnified.



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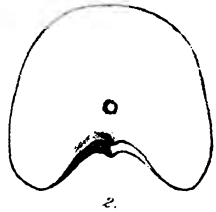

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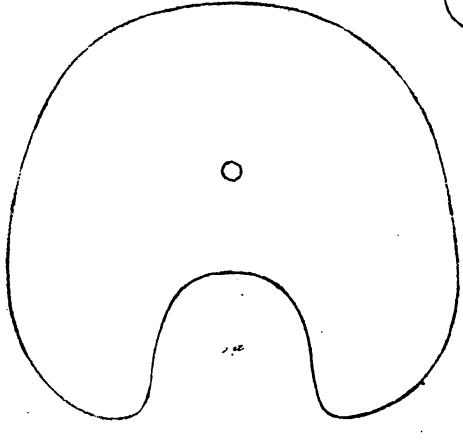

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PLATE XII.

HETEROCERAS CONRADI, Morton, Sp. (page 100.)

Figure 1. The best specimen of this species in the collection.

" 1 *a*. Detached portion of the uncoiled part of the same specimen.

" 2. Fragment of another individual, consisting of one of the early whorls, to show the width of the umbilicus at this stage of growth.

" 2 *a*. Another view of the same.

" 3. Fragment of a nearly adult shell, showing an upward curve of the whorl previous to uncoiling.

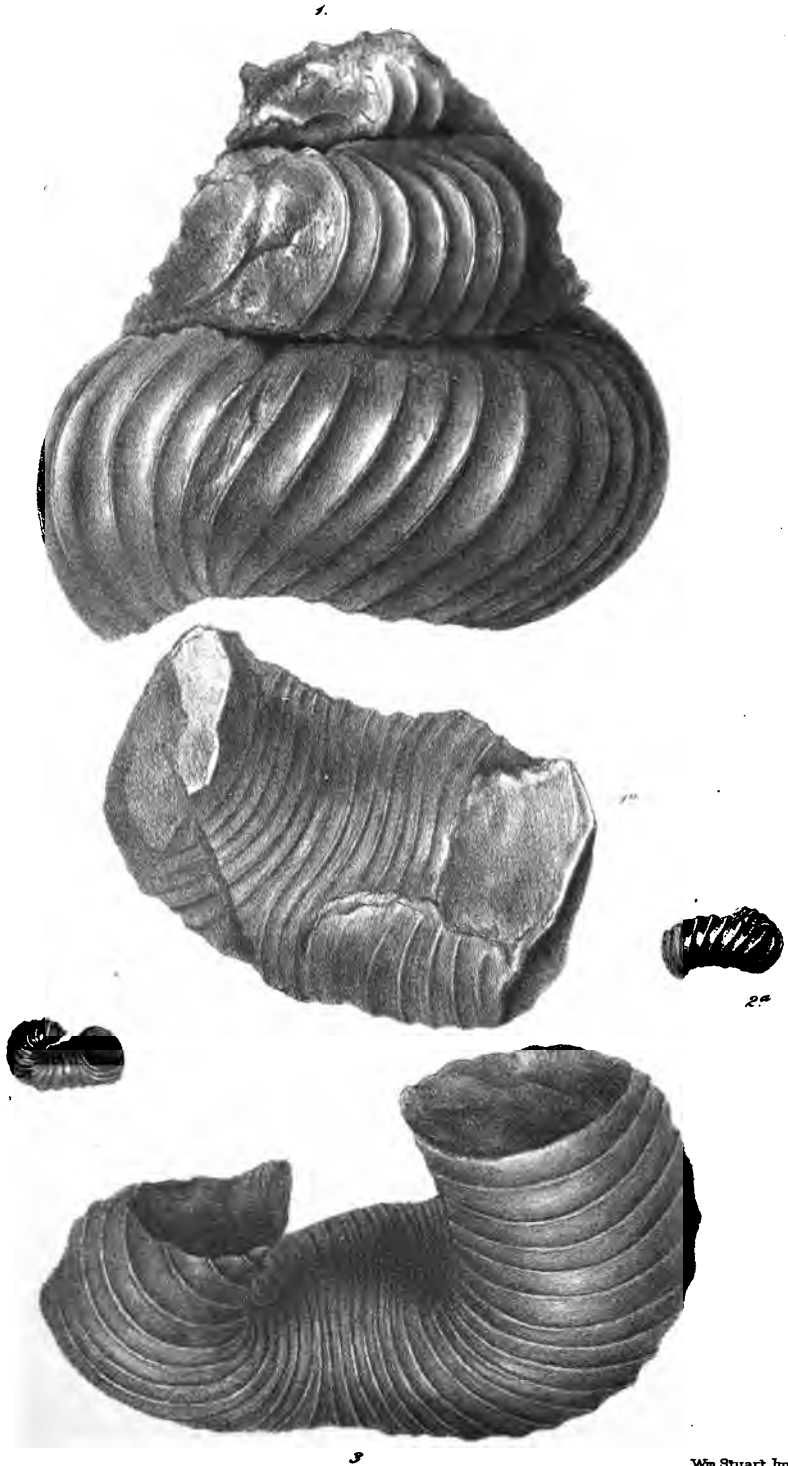

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PLATE XIII.

AMMONITES SELWYNIANUS (page 104.)

Figure 1. Front view of a cast of this species, with portions of the test adhering to it, to show the beak-like constrictions on the periphery.

" 1 *a*. Side view of ditto.

AMMONITES INDRA, Forbes (page 105.)

Figure 2. Side view of a large individual.

" 2 *a*. Portion of the side lobe (?) of the aperture of the same specimen.

AMMONITES JUKESII (?), Sharpe (page 111.)

Figure 3. Side view of the only specimen collected.

" 3 *a*. Outline of aperture of ditto.

" 3 *b*. Sculpture of ditto, magnified.

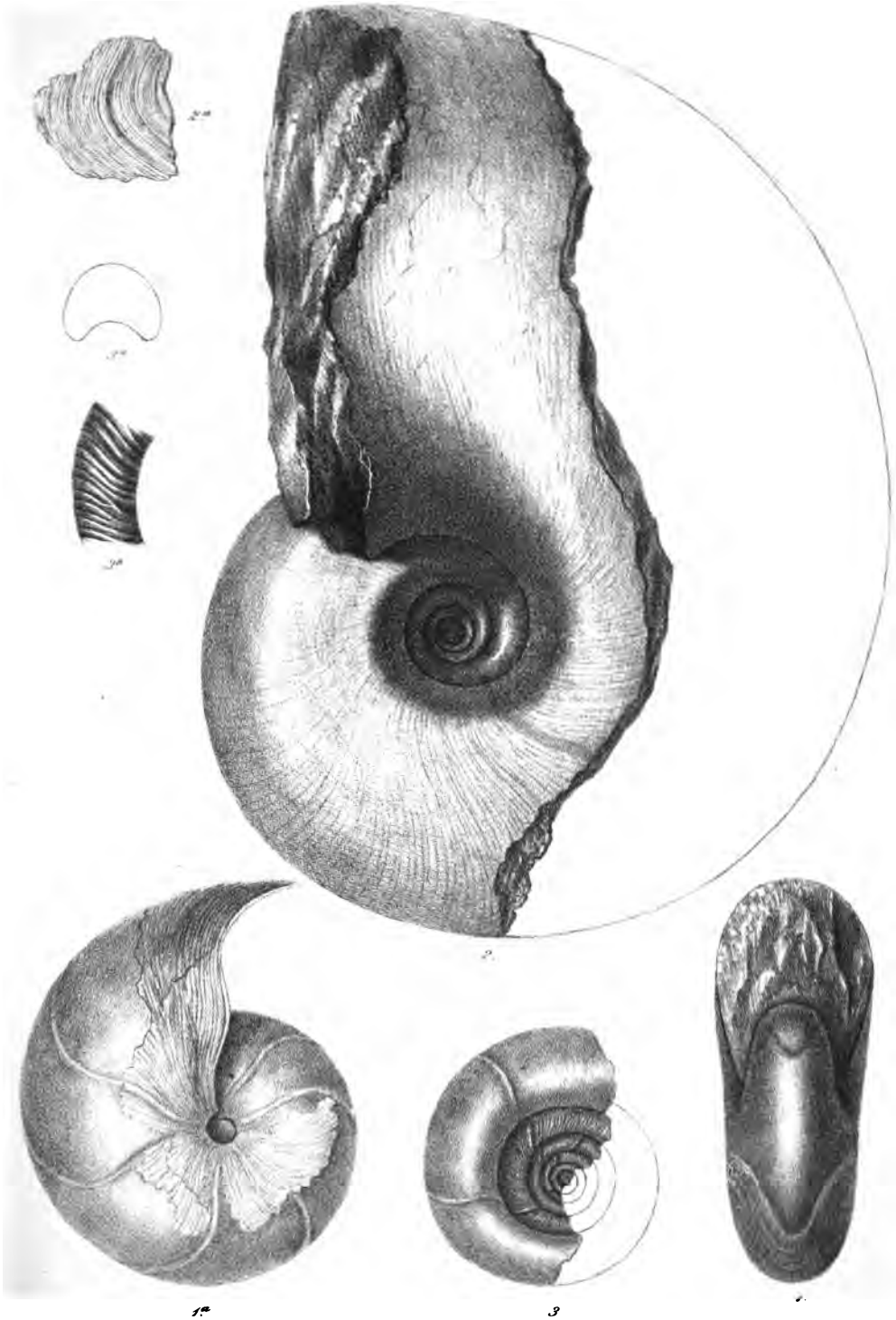

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PLATE XIV.

AMMONITES NEWBERRYANUS, Meek (page 109.)

Figure 1. Side view of a specimen with the test preserved

" 1 *a*. Outline of the aperture of another individual of the same species.

HAMITES CYLINDRACEUS (?), Defrance (page 113.)

Figure 2. Side view of the only specimen found.

" 2 *a*. Part of a septum of ditto.

PTYCHOCERAS VANCOUVERENSE (page 113.)

Figure 3. Side view of the last limb and part of the last but one.

" 3 *a*. Central or nearly central portion of the penultimate limb.

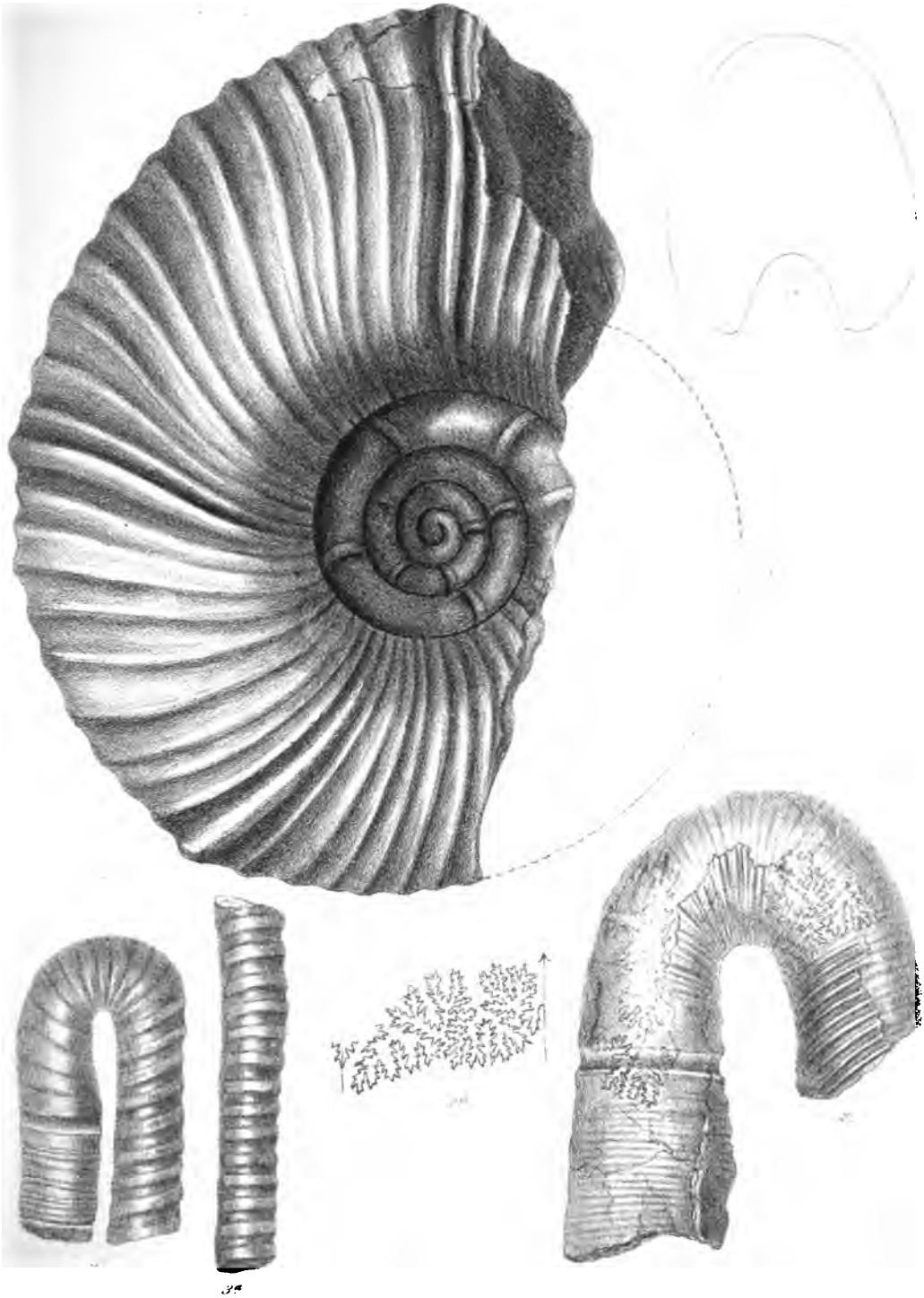

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PLATE XV.

SURCULA SUCIENSIS (page 115.)

Figure 1. Dorsal view of a specimen, magnified.
" 1 *a*. Actual length.

SURCULA RARICOSTATA, Gabb (page 116.)

Figure 2. Dorsal view, magnified, of the most perfect individual collected.
" 2 *a*. Actual length.

FULGURARIA NAVARROENSIS, Shumard, Sp. (page 117.)

Figure 3. View of an adult shell, to show the characters of the aperture, as far as known.
" 3 *a*. Spire of another example.

FUSUS KINGII, Gabb (page 119.)

Figure 4. Ventral aspect.

SERRIFUSUS DAKOTENSIS, VAR. VANCOUVERENSIS (page 119.)

Figure 5. Dorsal view of the only specimen known.

HINDSIA NODULOSA (page 125.)

Figure 6. Ventral view of a specimen from the Nanaimo River, V. I., to show the teeth and plaits on the columella. The outer lip is imperfect.
" 7. Dorsal view of an adult shell from the Sucia Islands.

POTAMIDES TENUIS, Gabb (page 121.)

Figure 8. A perfect, but immature individual, slightly enlarged.
" 8 *a*. Actual length.
" 8 *b*. Portion of the sculpture of the last whorl but one, magnified.

POTAMIDES TENUIS, VAR. NANAIMOENSIS (page 121.)

Figure 9. Ventral view of one of the best specimens collected.
" 9 *a*. Sculpture of penultimate whorl, magnified.

CERITHIUM LALLIERIANUM, VAR. SUCIENSE (page 122.)

Figure 10. Dorsal view of the shell, magnified.
" 10 *a*. Actual length.

ANCHURA STENOPTERA, Goldfuss, Sp. (page 123.)

Figure 11. Ventral view of the only specimen in the collection.
" 11 *a*. Dorsal aspect of ditto.

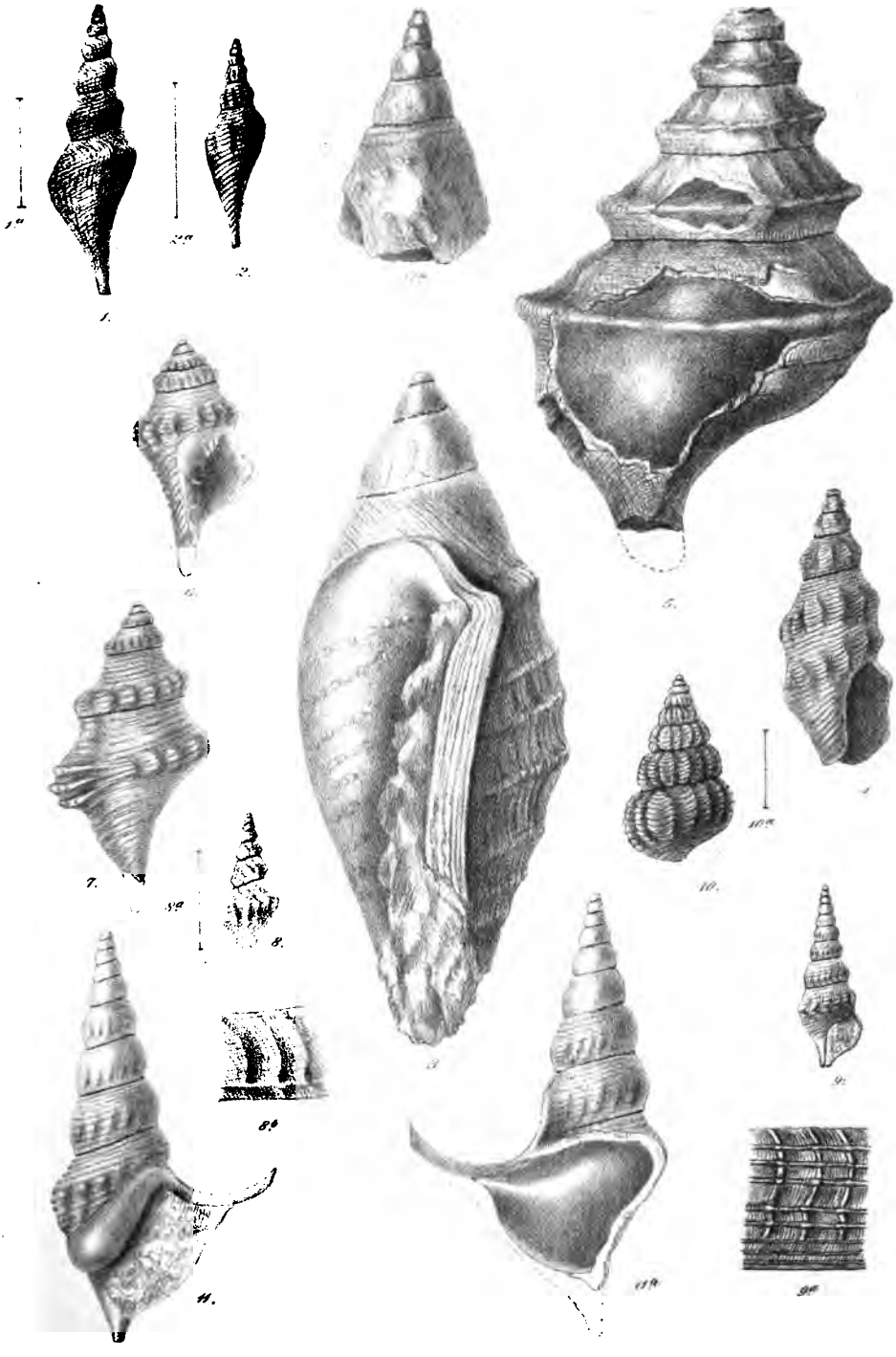

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PLATE XVI.

AMAUROPSIS SUCIENSIS (page 123.)

Figure 1. Ventral view of a specimen, to show the shape of the aperture and umbilicus.

GYRODES EXCAVATA, Michelin, Sp. (page 124.)

Figure 2. Dorsal view of a small variety of this species, from the Sucia Islands.
" 2 *a*. Ventral aspect of ditto.

CIRSOTREMA TENUISCULPTUM (page 127.)

Figure 3. Dorsal view of the type of the species, slightly enlarged.
" 3 *a*. Ventral aspect of the same.
" 3 *b*. Actual length.
" 3 *c*. Sculpture of body whorl, magnified.

STOMATIA SUCIENSIS (page 128.)

Figure 4. Dorsal view of a large but imperfect specimen, with the defective part restored in outline.

STOMATIA SUCIENSIS, VAR. CARINIFERA (page 128.)

Figure 5. Dorsal view of a specimen with four concentric ridges on the body whorl.

ACMEA, Sp. undt. (page 130.)

Figure 6. Cast of the interior, magnified, showing the muscular impressions.
" 6 *a*. Actual length.

CINULIOPSIS TYPICA (page 131.)

Figure 7. Ventral view of the type specimen, showing the mouth.
" 7 *a* Dorsal aspect of the same.
" 7 *b*. Sculpture of body whorl, magnified.

HAMINEA HORNII, Gabb, Sp. (page 132.)

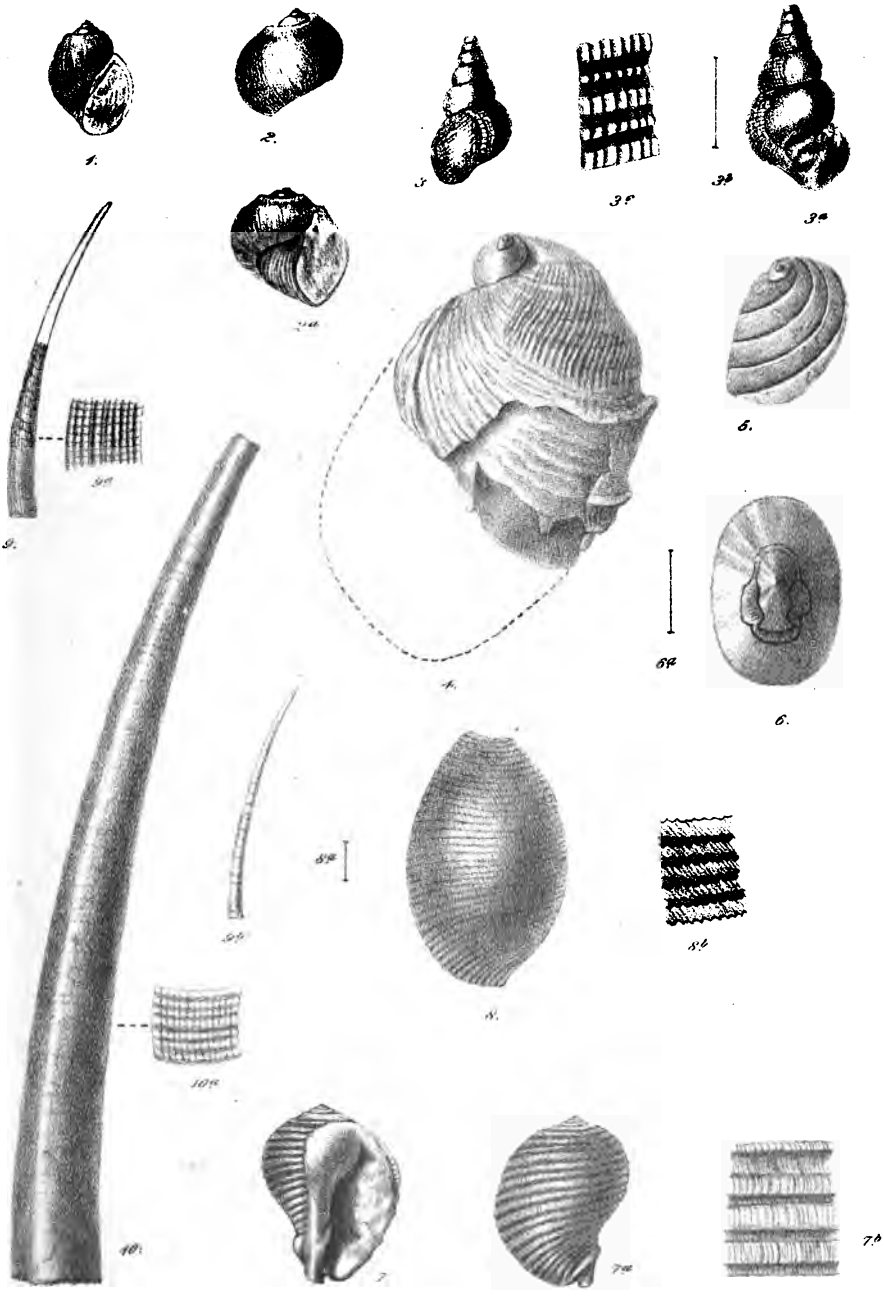
Figure 8. Dorsal view of a small but very perfect individual, magnified.
" 8 *a*. Actual length.
" 8 *b*. Portion of the surface markings, highly magnified.

DENTALIUM NANAIMOENSE, Meek (page 133.)

Figure 9. A large but imperfect individual, partly restored in outline
" 9 *a*. Sculpture of ditto, magnified.
" 9 *b*. A smaller but more perfect specimen.

ENTALIS COOPERI, Gabb, Sp. (page 134.)

Figure 10. A large and nearly perfect example.
" 10 *a*. Sculpture of the same, magnified.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7a.
7b.

PLATE XVII.

TEREDO SUCIENSIS (page 135.)

Figure 1. Right valve.
" 1 *a*. Portion of the shelly tube of another specimen.

MARTESIA CLAUSA, Gabb (page 137.)

Figure 2. Left valve of a perfect specimen.
" 2 *a*. Dorsal aspect of the same, to show the umbonal accessory plate.
" 2 *b*. Outline of ventral side of the same, showing the shape of the foot opening.

CORBULA TRASKII (?), Gabb (page 138.)

Figure 3. A right valve supposed to belong to this species.

CORBULA MINIMA, D'Orbigny (page 138.)

Figure 4. Right valve.
" 4 *a*. Left ditto.

ANATINA SULCATINA, Shumard (page 139.)

Figure 5. Right valve of a large and nearly perfect individual.
" 5 *a*. Left valve of another specimen.

PERIPLOMA SUBORBICULATUM (page 138.)

Figure 6. Right valve of the type of this species.

THRACIA SUBTRUNCATA, Meek (page 140.)

Figure 7. A left valve with the posterior extremity imperfect.

CYMBOPHORA ASHBURNERII, Gabb (page 141.)

Figure 8. Left valve of a specimen of the ribbed variety of this species.

MACTRA (CYMBOPHORA?) WARRENANA, Meek & Hayden (page 142.)

Figure 9. Left valve of an average example. The concentric striations of the surface are far too coarse, and, as the figure does not give a very good idea of the true sculpture of the shell, two additional illustrations of the species are given on plate 19.

TELLINA (ŒNE) Sp. undt. (page 143.)

Figure 10. Left valve of a small specimen.

TELLINA (PERONÆA) OCCIDENTALIS, Meek, Sp. (page 144)

Figure 11. Left valve, with the test preserved.
" 11 *a*. Cast of a left valve, showing the muscular impressions and the deep pallial sinus.

LINEARIA SUCIENSIS (page 146.)

Figure 12. Right valve of the only specimen collected.

CYTHEREA (CALLISTA) LACINIATA, Stoliczka (page 148.)

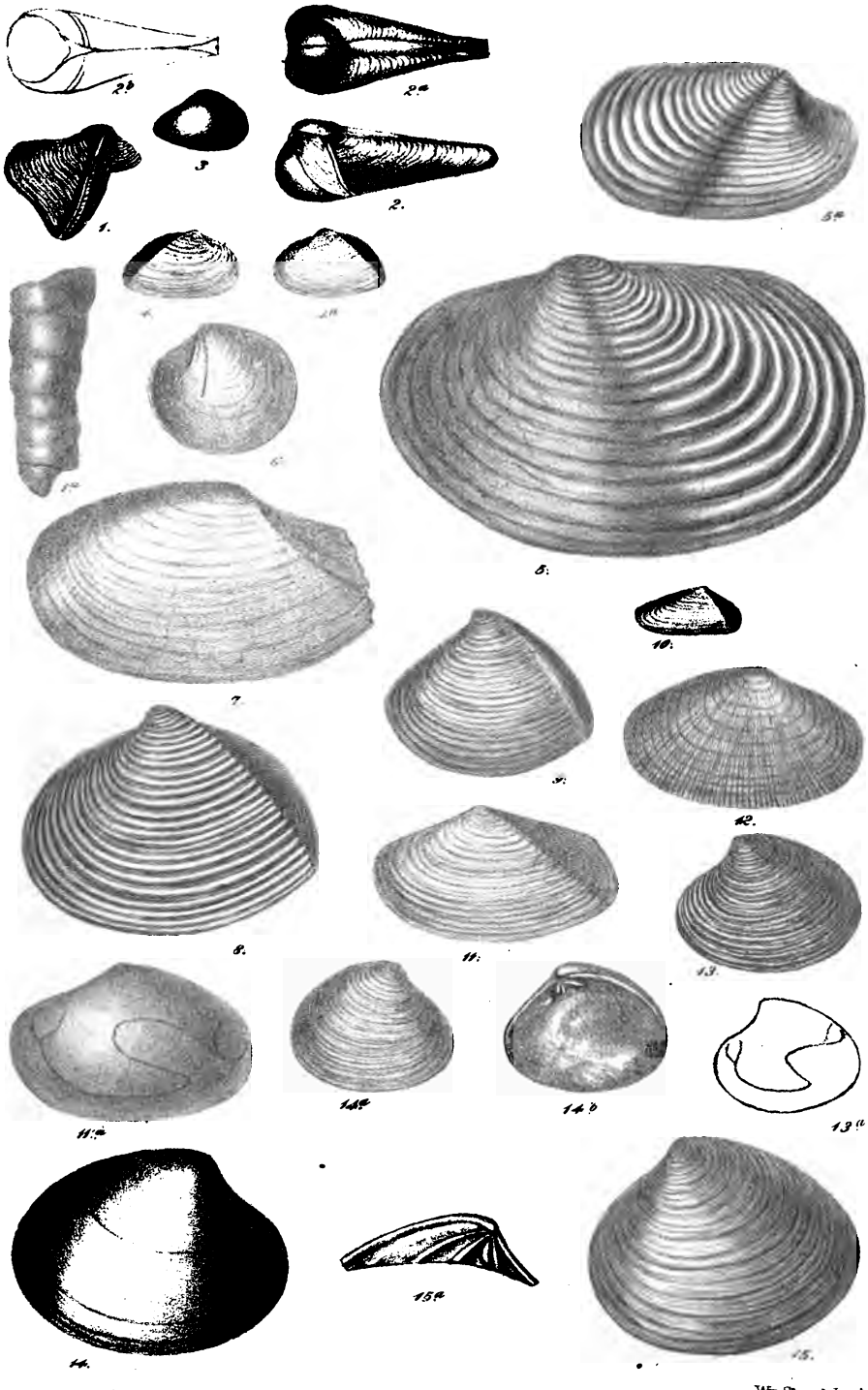
Figure 13. Left valve.
" 13 *a*. Outline of a cast of another left valve, showing the muscular impressions and pallial sinus.

CYTHEREA (CARYATIS) PLANA, Sowerby, Sp. (page 149.)

Figure 14. Right valve of a medium sized example.
" 14 *a*. Right valve of a smaller specimen.
" 14 *b*. Interior of the last, showing the hinge teeth.

CYPRIMERIA LENS, Gabb, Sp. (page 152.)

Figure 15. Left valve of a variety of this species.
" 15 *a*. Portion of interior of another left valve, showing the hinge teeth.



A.H. Foord. del'et lith.

Wm. Stuart. Imp!

PLATE XVIII.

VENIELLA CRASSA (page 153.)

Figure 1. Left valve of the type specimen, with the posterior extremity restored in outline.

LÆVICARDIUM SUCIENSE (page 154.)

Figure 2. Right valve of the largest specimen collected.

CLISOCOLUS CORDATUS, Meek & Hayden, Sp. (page 157.)

Figure 3. Left valve of a nearly perfect adult example.
" 3 *a*. Portion of the interior of a left valve, showing the hinge plate.
" 3 *b*. View of the corresponding portion of the right valve.

OPIS VANCOUVERENSIS (page 158.)

Figure 4. Exterior of a right valve of the only specimen known.
" 4 *a*. Interior of the same, showing the hinge teeth.

ASTARTE CONRADIANA, Gabb (page 160.)

Figure 5. View of a perfect example, with both valves.
" 5 *a*. Interior of a detached left valve, showing the hinge teeth and part of the crenulated basal margin.

ASTARTE CONRADIANA, VAR. TUSCANA (page 160.)

Figure 6. Side view of a perfect specimen, showing only the left valve, for comparison with figure 5.

TRIGONIA TRYONIANA, Gabb (page 161.)

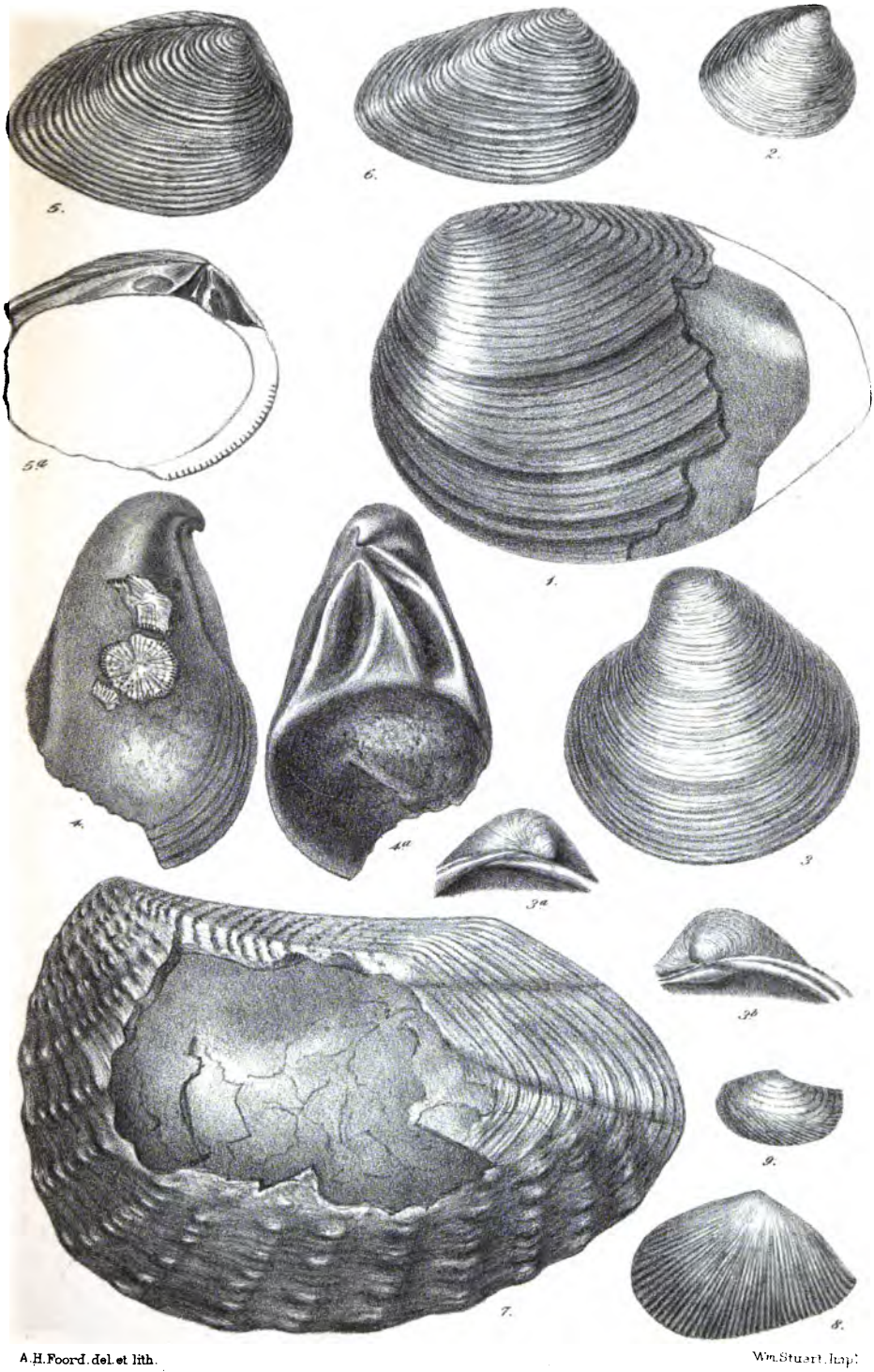
Figure 7. A left valve.

NUCULA PECTINATA (?), Sowerby, var. (page 161.)

Figure 8. Distorted left valve of a shell supposed to be a variety of this species.

YOLDIA STRIATULA, Forbes, Sp. (page 162.)

Figure 9. Left valve, enlarged, to show the surface markings more clearly.



A.H.Foord. del. et lith.

Wm.Stuart. lith.

PLATE XIX.

NEMODON VANCOUVERENSIS, Meek, Sp. (page 163.)

Figure 1. Left valve of a fine adult specimen.

" 1 *a*. Interior of a right valve, showing the hinge dentition.

CUCULLÆA (IDONEARCA) TRUNCATA, Gabb (page 165.)

Figure 2. Specimen in which the posterior side is unusually short and truncated almost vertically at its extremity.

" 2 *a*. Another example whose posterior side is produced and truncated very obliquely at its margin. This is the form of the species which is most like Meek's figure of C. Nebrascensis, Owen.

MACTRA (CYMBOPHORA ?) WARRENANA, Meek & Hayden (page 142.)

Figure 3. Left valve, side view.

" 3 *a*. Right valve of another specimen.

CYTHEREA (CALLISTA) LACINIATA, Stoliczka (page 148.)

Figure 4. Left valve.

" 4 *a*. Sculpture of the same, magnified.

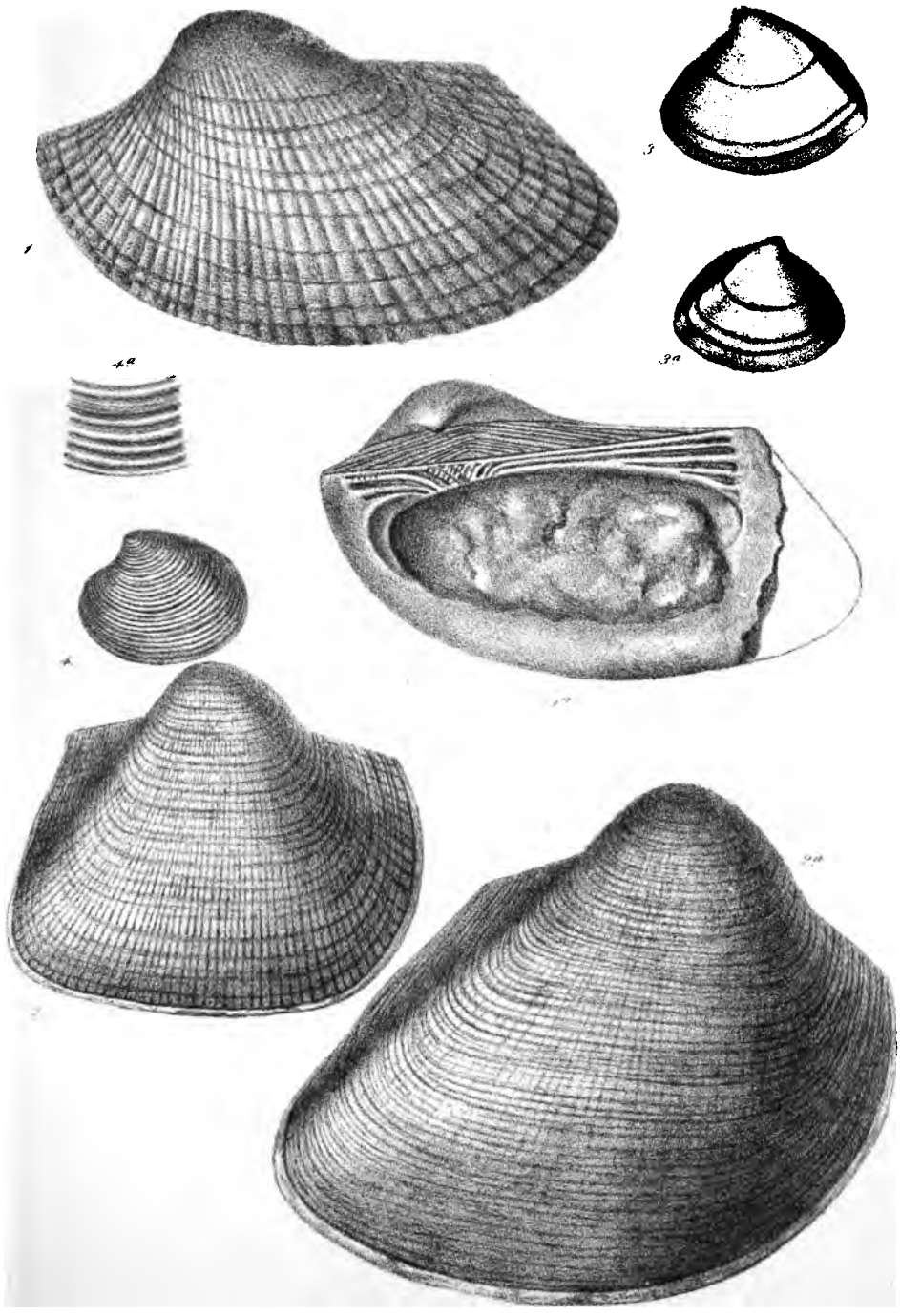

1
3
3a
4a
4
5
5a

PLATE XX.

PINNA CALAMITOIDES, Shumard (page 167.)

Figures 1, 1 *a* and 1 *b*. Three detached fragments of this species.

INOCERAMUS UNDULATO-PLICATUS, Rœmer (page 168.)

Figure 2. Right valve of a young but perfect specimen.

" 2 *a*. Left valve of another immature shell.

INOCERAMUS MYTILOPSIS, Conrad (page 169.)

Figure 3. Left valve of an aberrant form of this species.

INOCERAMUS VANCOUVERENSIS, Shumard (page 170.)

Figure 4. Left valve of a specimen whose length and height are nearly equal.

" 4 *a*. The most common form of the species, in which the height considerably exceeds the length.

" 4 *b*. Umbonal region of a specimen whose beaks are abnormally developed.

ANOMIA VANCOUVERENSIS, Gabb (page 175.)

Figures 5 and 5 *a*. Two upper valves, which retain the markings of some ribbed shell on which they have grown.

" 5 *b*. An upper valve, showing the true surface markings.

" 5 *c*. Side view of the same, to shew the amount of convexity.

" 5 *d*. Minute radiating striæ of the test, highly magnified.

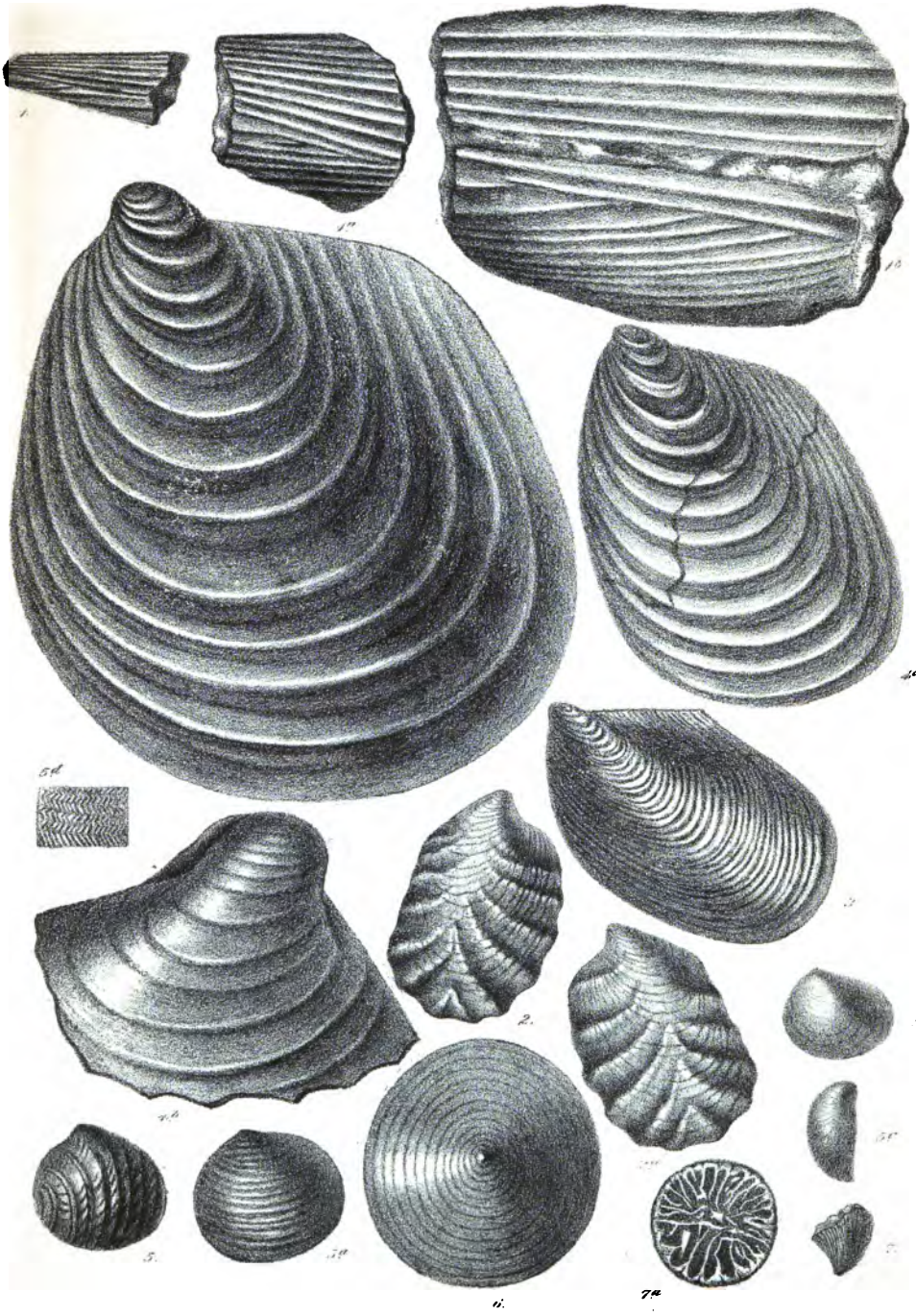
DISCINA VANCOUVERENSIS (page 177.)

Figure 6. Upper valve of the type specimen.

SMILOTROCHUS VANCOUVERENSIS (page 178.)

Figure 7. Side view of the only specimen.

" 7 *a*. Transverse section of the same, at or near the summit.



A.H.Foord del et lith

Wm.Stuart.Imp!